HandyPort

How to use the Multipoint Mode

Application Notes

2019. 11. 08.
AN-2010-19E
Version 1.1

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HandyWave Co., Ltd.

#604, 912, Seongnamdaero, Bundang-gu, Seongnam-si, Gyunggi-do, 13506, South Korea

Tel: 82-31-709-8900, Fax: 82-31-708-9455, https://handywave.co.kr/ab-1212

How to use the Multipoint Mode[1], Application Notes, AN-2010-19E, Version 1.1, 2019. 11. 08.

[1] To support the multipoint functions, the HandyPort has to be the software version 3.2 and above.

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1. Introduction

This document describes how to use the Multipoint Mode in HandyPort networks.

1.1. HandyPort Network

HandyPort network is supporting Point-to-Point and Point-to-Multipoint networking from the software version 3.2. To use multipoint functions in HandyPort, the HandyPort has to have the software version 3.2 and above.

1.2. Features

The HandyPort provides the following features to support the multipoint network.

- Supports Point-to-Point, Point-to-Multipoint, and Multipoint-to-Multipoint Communications
- Supports router functions with MN (Master Node) and SN (Sub Node)
- Supports Repeater functions with SN Repeater
- Supports up to 260 Nodes for the Master-Slave Communications
- Supports HUB and Unicast Networking
- Supports Unicast, Broadcast, and Multicast

1.3. Organization

This document is organized as follows:

Chapter 1. Introduction

Chapter 2. Setup Procedures

Chapter 3. SN Repeater Setup

Chapter 4. Multipoint Mode of Tree Architecture

1.4. Revision History

Table 1-1 Revision History

Revision	Date	Reason for Change
1.1	2019. 11. 08.	Changed zip code and web page address
1.0	2007. 06. 30.	Original publication of this document

1.5. Acronyms

Table 1-2 Acronyms

Acronym	Definition
BD_ADDR	Bluetooth Device Address
CoD	Class of Device
<CR>	Carriage Return
EN	End Node
ENm	Master End Node
LED	Light Emitting Diode
SN	Sub Node
MN	Master Node

1.6. References

1. HPS-120 User's Manual

2. HPS-110 User's Manual

3. HPS-200 User's Manual Version 1.0, 2007. 04. 07, HandyWave Doc. No. SYM-2200-2E

4. Multipoint Mode User's Manual, Version 1.0, 2007. 05. 31, HandyWave Doc. No. SYM-2300-2E

5. Extended Command Set User's Manual, Version 1.0

2. Setup Procedures

This chapter describes the setup procedures of multipoint mode in HandyPort.

2.1. Point-to-Point Setup

Please refer to each user's manuals of HandyPort series.

2.2. SN Repeater Setup

SN Repeater network consists of an EN1, a SN Repeater, and an EN2. You can configure the SN Repeater network as follows:

Step 1: Configure the EN1's connection mode to WAIT and find out the BD_ADDR of EN1 to configure the SN Repeater.

Step 2: Configure the SN Repeater to repeater mode using a multipoint mode command and set EN1's BD_ADDR to the remote BD_ADDR. And find out the BD_ADDR of SN Repeater to configure the EN2.

Step 3: Configure the EN2's connection mode to Register & Connect and set SN Repeater's BD_ADDR to the remote BD_ADDR.

Step 4: Verify the EN1-SN Repeater-EN2 network using a command at SN Repeater and test data communication between the EN1 and EN2.

2.3. Multipoint Mode of Tree Architecture

The multipoint mode of tree architecture consists of a basic mode, a HUB mode, and a Unicast mode. The tree network can consist of an ENm, a MN, SNs, and ENs. If the network consists of an ENm, a MN, and ENs, it can be a star architecture. Therefore, we'll not describe the setup procedures of star architecture.

2.3.1. Procedures of Multipoint Mode Selection

The procedures of multipoint mode selection are shown in Figure 2-1.

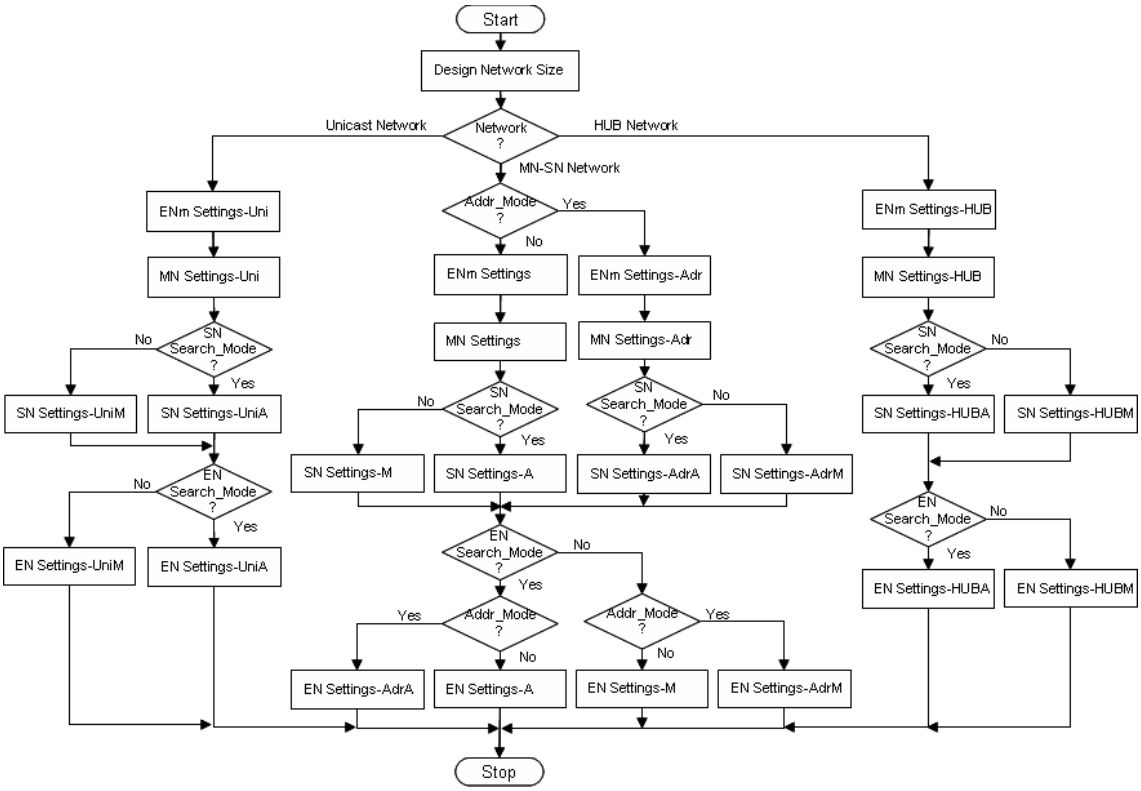


Figure 2-1 Procedures of Multipoint Mode Selection

2.3.1.1. Design the Network

You need to calculate the required nodes and its type from the existing wired network or new network. You may refer to the user's manual of multipoint mode to get more information about the HandyPort network.

2.3.1.2. Determine the Network Type

You need to select a network type, which is the best fit to your original network, from the HandyPort network. You may refer to the user's manual of multipoint mode to get more information about the HandyPort network.

2.3.1.3. ENm Configuration

Once you've made a decision on the network size and type, you need to configure the ENm. The ENm is the master of whole network. The types of ENm setting can be as follows:

- ENm Settings: Configure the ENm for MN-SN-EN Network
- ENm Settings-Adr: Configure the ENm with the address mode for MN-SN-EN Network
- ENm Settings-HUB: Configure the ENm for MN HUB-SN HUB-EN Network
- ENm Settings-Uni: Configure the ENm for MN Unicast-SN Unicast-EN Network

2.3.1.4. MN Configuration

The MN is the master routing node of the HandyPort network. The types of MN setting can be

as follows:

- MN Settings: Configure the MN for MN-SN-EN Network
- MN Settings-Adr: Configure the MN with the address mode for MN-SN-EN Network
- MN Settings-HUB: Configure the MN for HUB-SN HUB-EN Network
- MN Settings-Uni: Configure the MN for MN Unicast-SN Unicast-EN Network

2.3.1.5. SN Configuration

The SN performs the routing functions in the HandyPort network. The types of SN setting can be as follows:

- SN Settings-A: Configure the SN using the search mode for MN-SN-EN Network
- SN Settings-M: Configure the SN with the manual setting for MN-SN-EN Network
- SN Settings-AdrA: Configure the SN using the address mode and search mode for MN-SN-EN Network
- SN Settings-AdrM: Configure the SN using the address mode and manual setting for MN-SN-EN Network
- SN Settings-HUBA: Configure the SN using the search mode for MN HUB-SN HUB-EN Network
- SN Settings-HUBM: Configure the SN using the manual setting for MN HUB-SN HUB-EN Network
- SN Settings-UniA: Configure the SN using the search mode for MN Unicast-SN Unicast-EN Network
- SN Settings-UniM: Configure the SN using the manual setting for MN Unicast-SN Unicast-EN Network

2.3.2. EN Setup

The types of EN setting can be as follows:

- EN Settings-A: Configure the EN using the search mode for MN-SN-EN Network
- EN Settings-M: Configure the EN using the manual setting for MN-SN-EN Network
- EN Settings-AdrA: Configure the EN using the search and address mode for MN-SN-EN Network
- EN Settings-AdrM: Configure the EN using the manual setting and address mode for MN-SN-EN Network
- EN Settings-HUBA: Configure the EN using the search mode for MN HUB-SN HUB-EN Network
- EN Settings-HUBM: Configure the EN using the manual setting for MN HUB-SN HUB-EN Network
- EN Settings-UniA: Configure the EN using the search mode for MN Unicast-SN Unicast-EN Network

- EN Settings-UniM: Configure the EN using the manual setting for MN Unicast-SN Unicast-EN Network

2.3.3. Search Mode versus Manual Setting

You can configure the SN and EN to make a connection with an upper node using either the search mode or manual setting. The Table 2-1 shows the comparison between the search mode and manual setting at the SN and EN.

Table 2-1 Search Mode versus Manual Settings

Item	Search Mode	Manual Setting
Overview	Find an upper node using a query CoD, and negotiate a serial port to make a connection. Activate the Search Mode and select a type of upper node.	Designate an upper node. Set the BD_ADDR of upper node and a serial port at the SN or EN.
Settings	Can be set the mode using a search mode command, [AT+Z]L<F><1><CR>.	Need to set a BD_ADDR of upper node and a serial port using [AT+Z]<A><BD_ADDR><CR> and [AT+Z]<C><COM><CR> at each SN and EN.
Connecting	Find an upper node that has the query CoD and try to connect to it.	As powered on, it tries to connect to the designated upper node.
Upper Node	Can be changed.	Cannot be changed.
Applications	Doesn't need to be a fixed upper node and serial port.	Must use a designated upper node and serial port.
Advantages	Easy to setup. Can be connecting to another node, if the previous upper node stops working.	Make a connection with the designated upper node and serial port. Can be made a quick connection.
Disadvantages	Can be changed the upper node and serial port. Can be taken a long connection time.	Complicated setup procedures. If the upper node stops working, it will be disconnected from network.

3. SN Repeater Setup

This chapter describes the setup procedures of SN Repeater. We will use the button mode to take an example for setup.

If you're not using the button mode, you have to use a command sequence, AT+Z. And we do recommend you to use "WAIT" mode to make yourself easy for setting of HandyPort.[1]

3.1. Setup the SN Repeater Network

You can use the SN Repeater network to extend the coverage between two ENs. SN Repeater network consists of an EN1, a SN Repeater, and an EN2. You can setup the SN Repeater network as follows:

Step 1: Configure the EN1's connection mode to WAIT and find out the BD_ADDR of EN1 to configure the SN Repeater.

Step 2: Configure the SN Repeater to repeater mode using a multipoint mode command and set EN1's BD_ADDR to the remote BD_ADDR. And find out the BD_ADDR of SN Repeater to configure the EN2.

Step 3: Configure the EN2's connection mode to Register & Connect and set SN Repeater's BD_ADDR to the remote BD_ADDR.

Step 4: Verify the EN1-SN Repeater-EN2 network using a command at SN Repeater and test data communication between the EN1 and EN2.

3.1.1. Configure the EN1

Step 1: Push the RST button to enter the setup mode, and hit a <CR> after 5 sec.

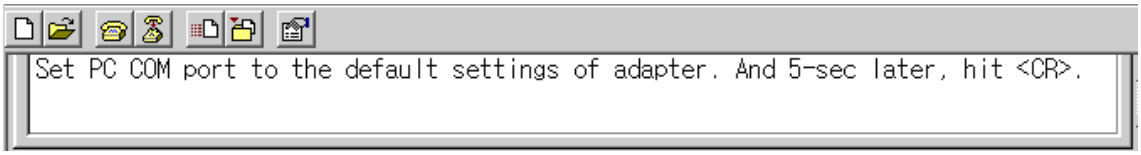


Figure 3-1 Enter the Setup Mode at EN1

[1] How to change the connection mode to WAIT: Please use "AT+ZM1<CR>" and "AT+ZX".

Step 2: Type a command, M, and type “1<CR>” to change the connection mode to WAIT. And find out the BD_ADDR of EN1 for SN Repeater.

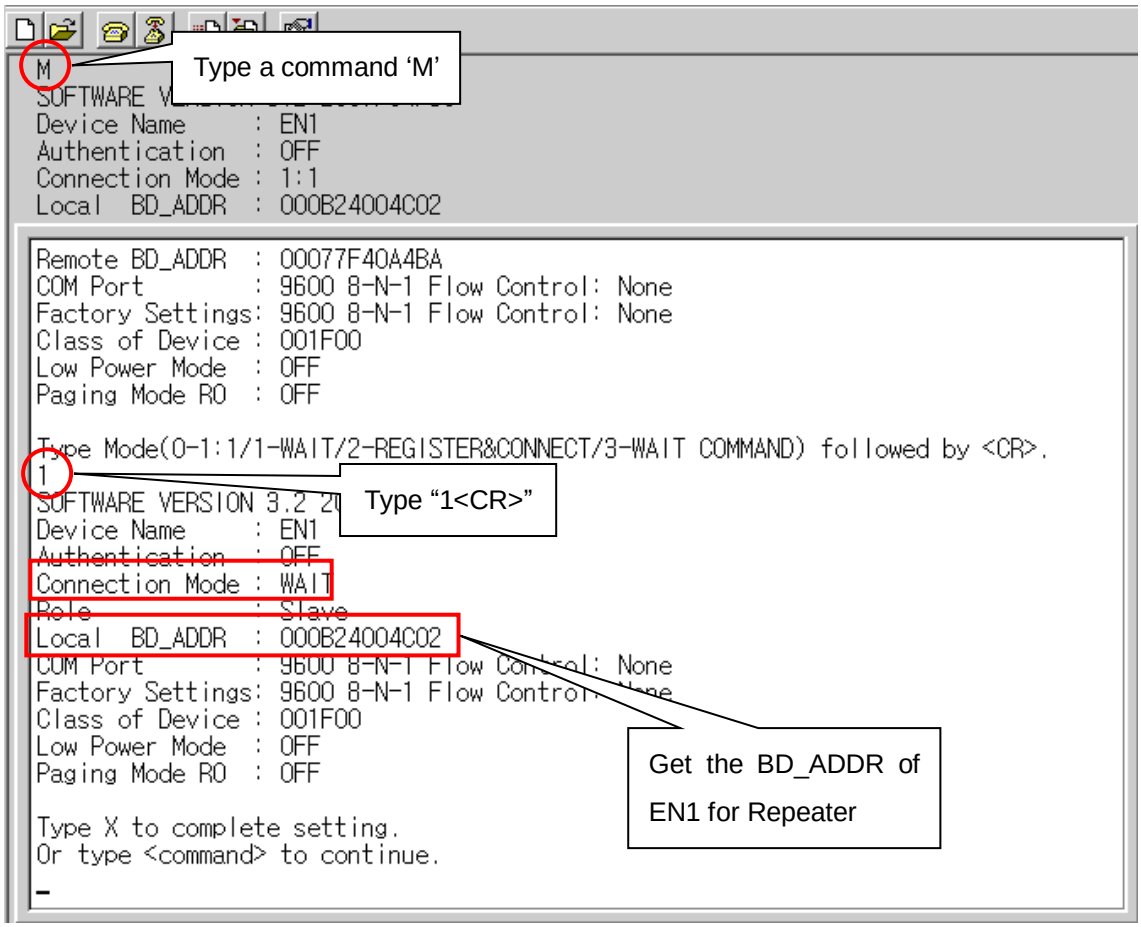


Figure 3-2 Configure the Connection Mode at EN1

Step 3: Type a command, LR, and verify the changes and type a command, X, to apply the changes.

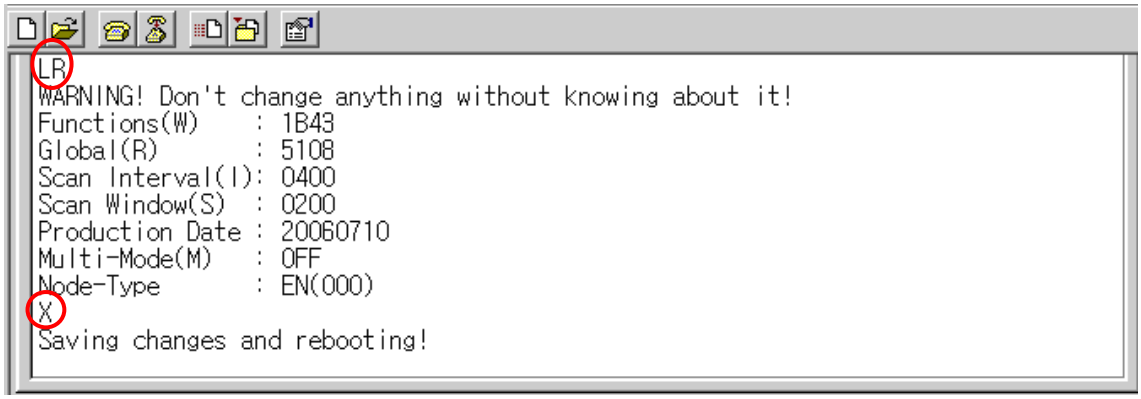


Figure 3-3 Verification with LR and Exit

3.1.2. Configure the SN Repeater

Step 1: Push the RST button to enter the setup mode, and hit a <CR> after 5 sec.

Step 2: Type a multipoint mode command, LM, and type “1<CR>” to configure it to Repeater. The operation mode will be changed to the extended command mode by selecting Repeater automatically.

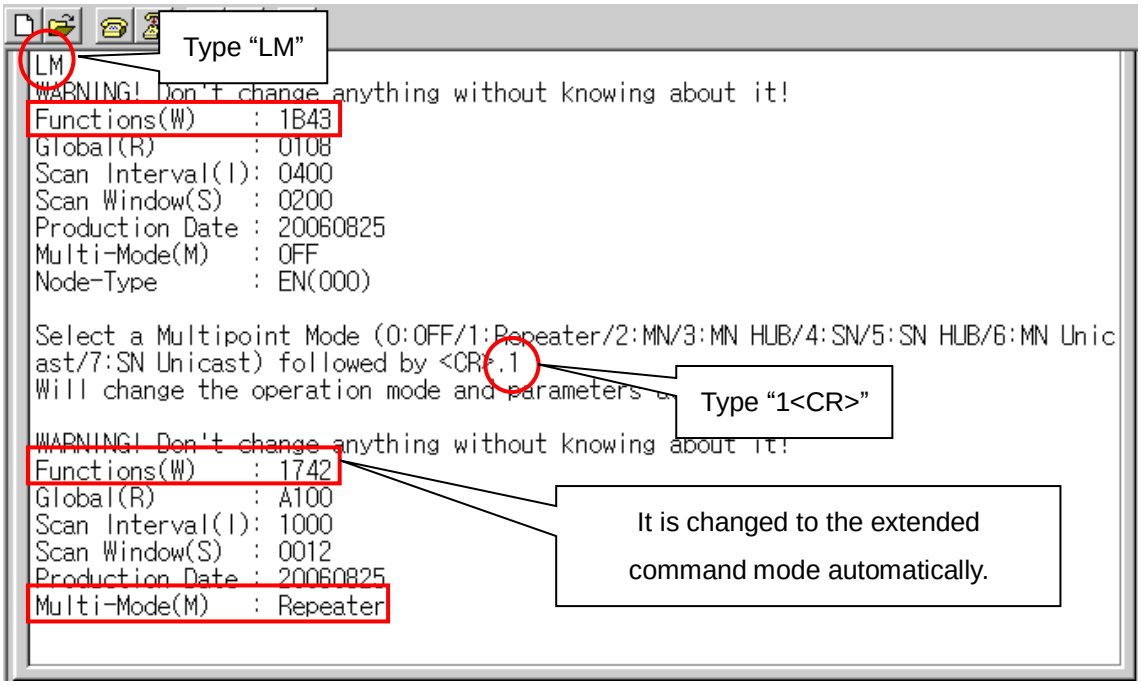


Figure 3-4 Configure the SN Repeater

Step 3: Type a command, A, and type the BD_ADDR of EN1 followed by <CR> to configure the remote BD_ADDR to EN1. Find out the BD_ADDR of SN Repeater for EN2. And the Serial Port shall be '1'. If it is not, you can set it up by typing 'C' and "1<CR>".

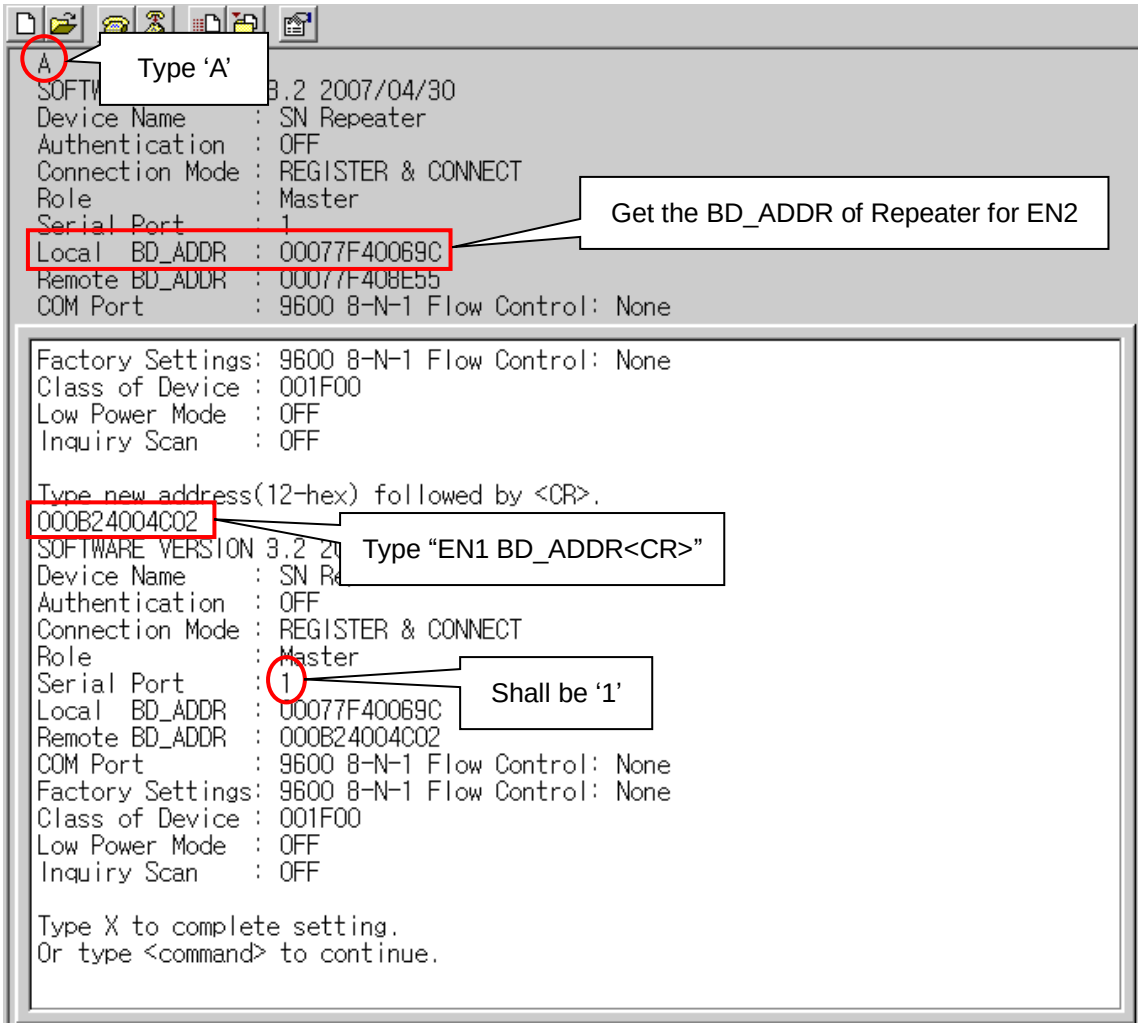


Figure 3-5 Configure the Remote BD_ADDR at SN Repeater

Step 4: Verify the changes and type a command, X, to apply the changes and reboot.

3.1.3. Configure the EN2

Step 1: Push the RST button to enter the setup mode, and hit a <CR> after 5 sec.

Step 2: Type a command, M, and type "2<CR>" to change the connection mode to "Register & Connect" mode. The Serial Port shall be '1'. If it's not, you can set it up by typing 'C' and "1<CR>".

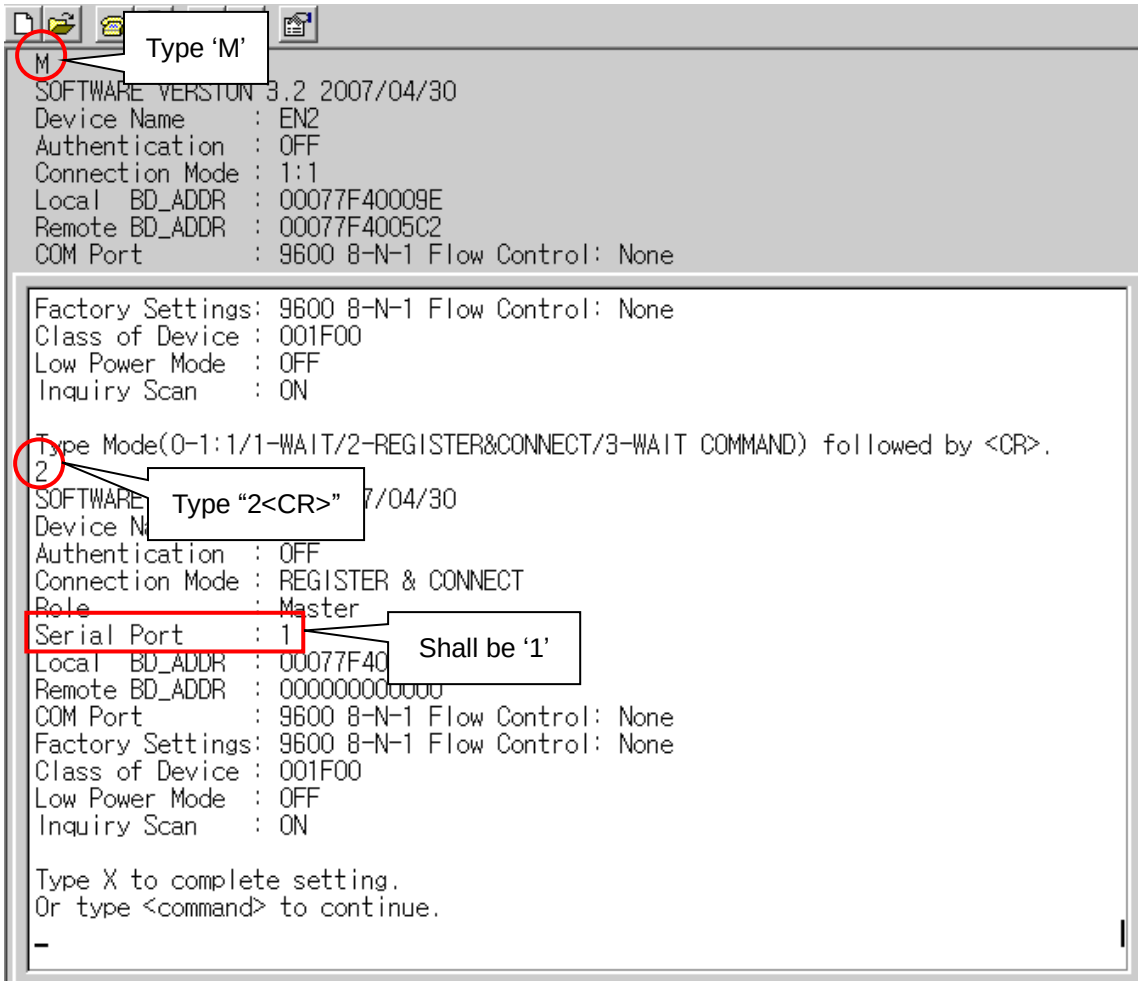


Figure 3-6 Configure the Connection Mode at EN2

Step 3: Type a command, A, and type the BD_ADDR of SN Repeater followed by <CR>.

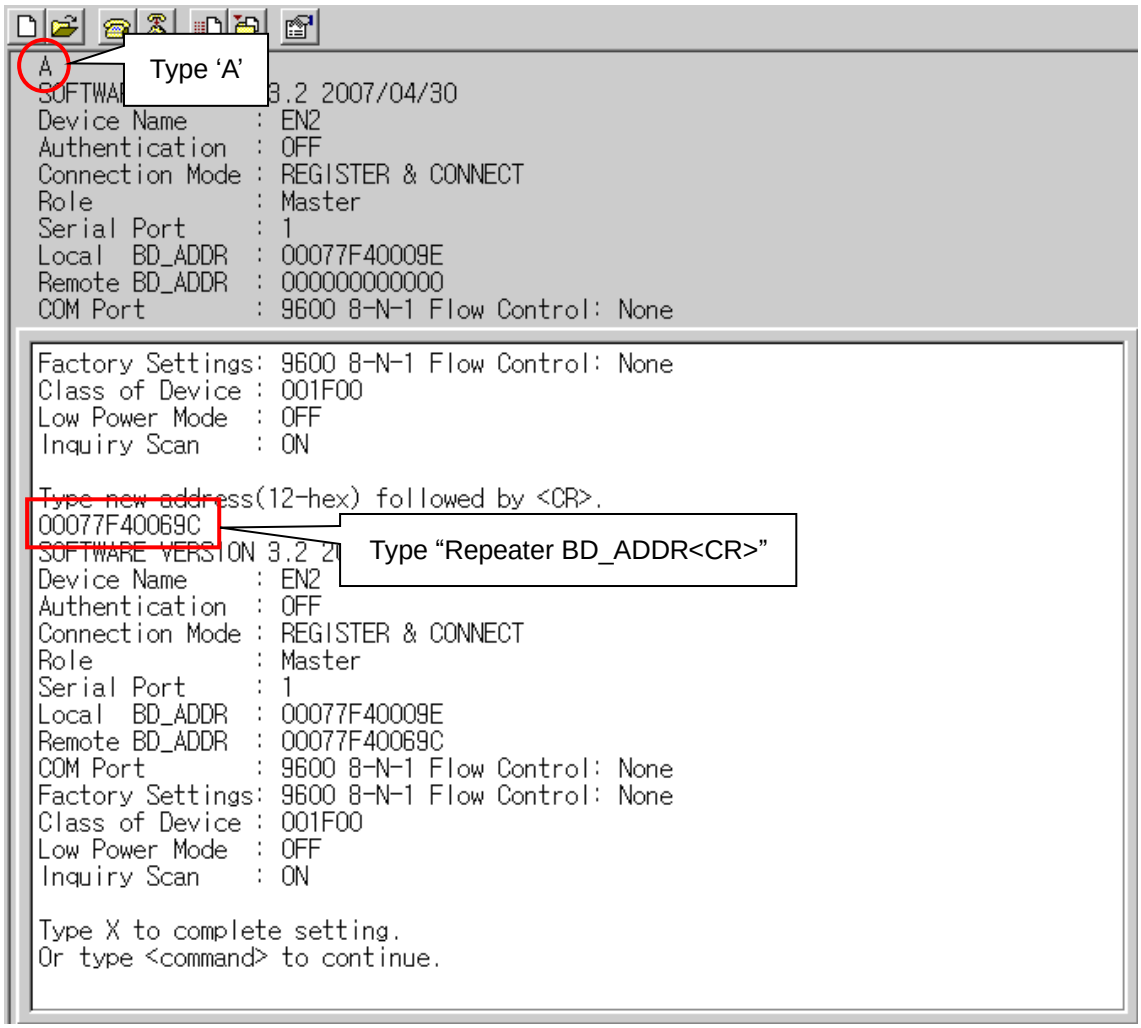


Figure 3-7 Configure the Remote BD_ADDR at EN2

Step 4: Verify the changes and type a command, X, to apply the changes and reboot.

3.2. Verification of SN Repeater Network

You can verify the setting by the status LED and command at SN repeater for SN Repeater Network.

3.2.1. Connection Verification using LED Status

It will make a connection between the SN Repeater and EN1 firstly, and the second connection will bring up between the EN2 and SN Repeater. If it is connected, its green LED will turn on steadily. And if there has not been made a connection between the SN Repeater and EN1, the EN2 cannot connect to the SN Repeater.

3.2.2. Connection Verification using a command at SN Repeater

You can use a serial port at SN Repeater only for debugging. And the SN Repeater uses the extended command mode.

3.2.2.1. The Command List for SN Repeater

You can see the command list by typing “AT+ZL?” at SN Repeater.

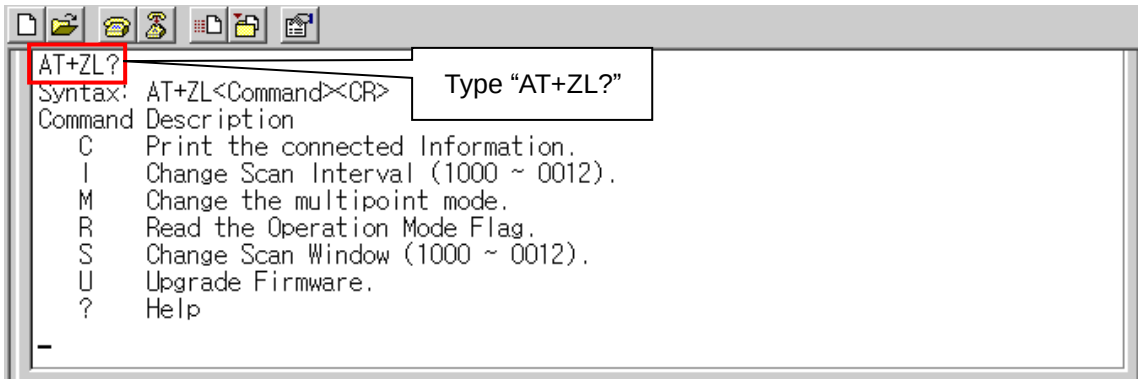


Figure 3-8 Print the Command List at SN Repeater

3.2.2.2. Verification of ENs Status by Command

You can verify the status of EN1 and EN2 by typing a command, AT+ZLC, at SN Repeater. It will show the status of SN Repeater Network.

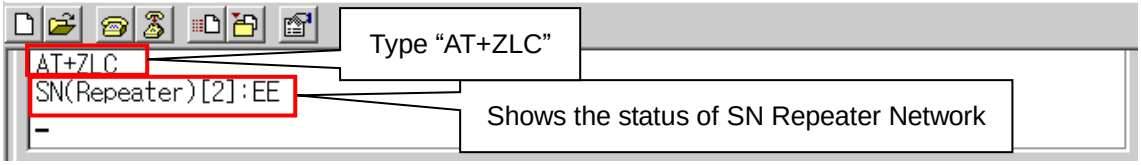


Figure 3-9 Print the Status of Nodes at SN Repeater

No text.

4. Multipoint Mode of Tree Architecture

This chapter describes the setup procedures of each node in the multipoint mode of tree architecture. We will use the button mode to take an example for configuring multipoint mode.

If you're not using the button mode, you have to use a command sequence, AT+Z. And we do recommend you to use "WAIT" mode to make yourself easy for HandyPort setting.[1]

4.1. ENm Configuration

The ENm will be connected to the device that is the master of network. This section describes the procedures of ENm configuration. The following are the features of ENM.

- Connection Mode: WAIT Mode
- Connected to the device that is the master of network
- It has an incoming connection that is connected to MN.

4.1.1. ENm Settings

This is the procedures for configuring ENm in MN-SN-EN network.

Step 1: Push the RST button to enter the setup mode, and hit a <CR> after 5 sec.

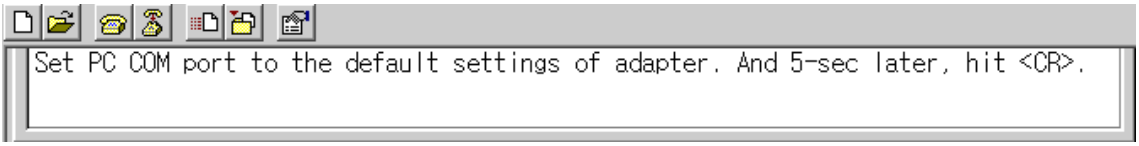


Figure 4-1 Enter the Setup Mode at ENm

[1] How to change the connection mode to WAIT: Please use "AT+ZM1<CR>" and "AT+ZX".

Step 2: Type a command, M, and type “1<CR>” to change the connection mode to WAIT.

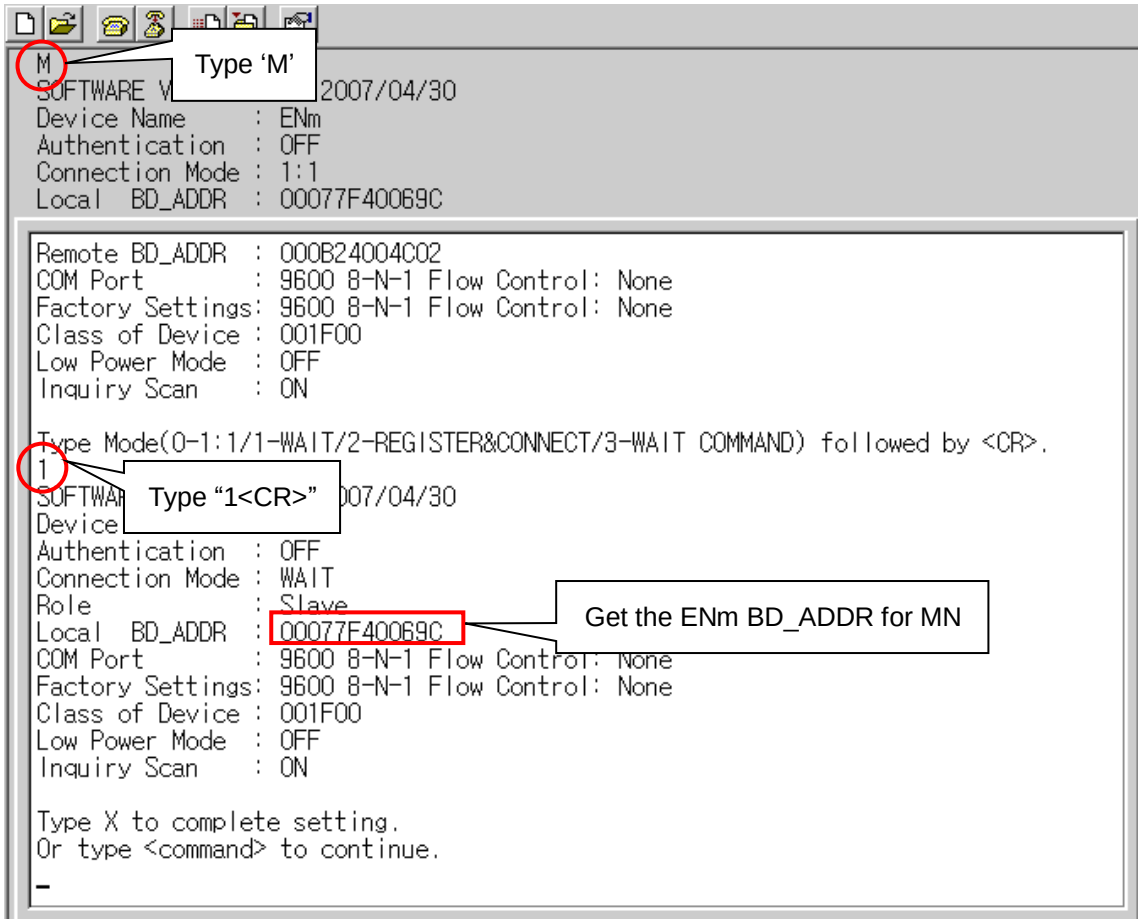


Figure 4-2 Configure the Connection Mode for ENm

Step 3: Find out the BD_ADDR of ENm for setting MN.

Step 4: Verify the changes and type a command, X, to apply the changes and reboot.

Figure 4-3 Execute ‘X’ at ENm

4.1.2. ENm Settings-Adr

This is the procedures for configuring ENm with address mode in MN-SN-EN network.

Step 1: Push the RST button to enter the setup mode, and hit a <CR> after 5 sec.

Step 2: Type a command, M, and type “1<CR>” to change the connection mode to WAIT. (Please refer to Figure 4-2)

Step 3: ENm Find out the BD_ADDR of ENm for setting MN. (Please refer to Figure 4-2)

Step 4: Type a command, LW, and type “E<CR>” to change the operation mode to the extended command mode.

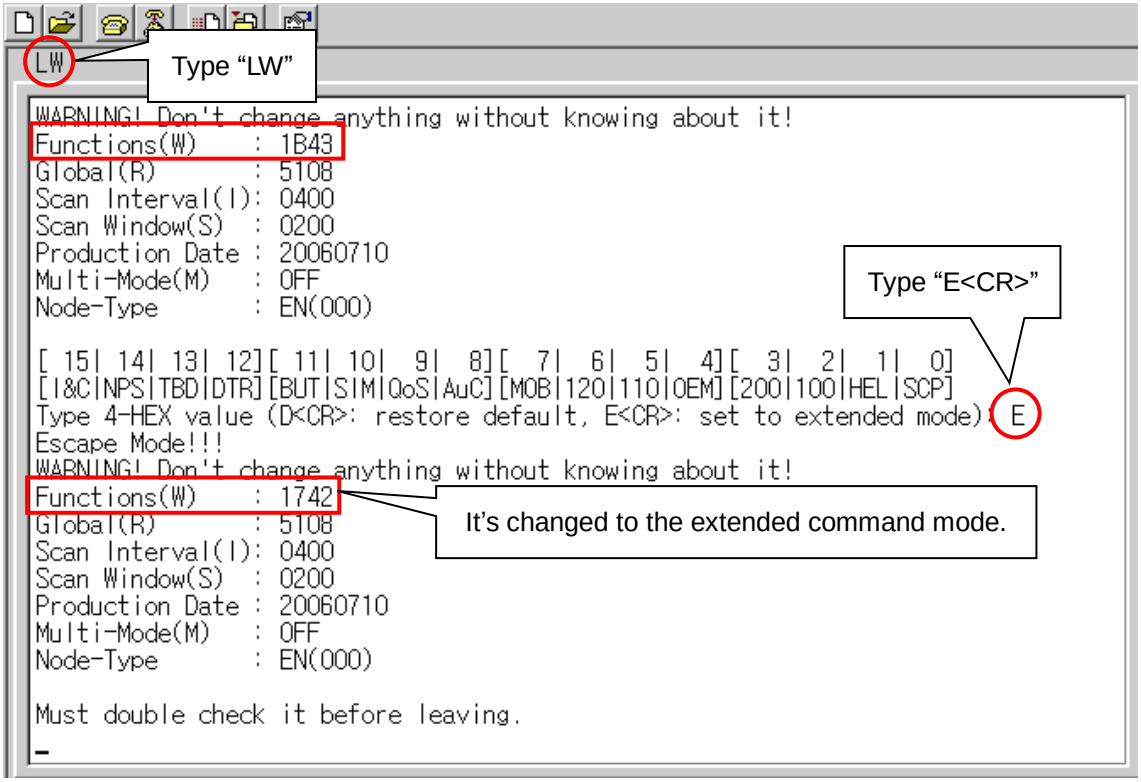


Figure 4-4 Configure the Operation Mode for ENm

Step 5: Verify the changes and type a command, X, to apply the changes and reboot. You have to use the command sequence, AT+Z, after rebooting.

4.1.3. ENm Settings-HUB

This is the procedures for configuring ENm in MN HUB-SN HUB-EN network. The procedures are the same as section 4.1.1 exactly.

4.1.4. ENm Settings-Uni

This is the procedures for configuring ENm in MN Unicast-SN Unicast-EN network. The procedures are the same as section 4.1.2 exactly.

4.2. MN Configuration

This section describes the procedures of configuring MN. The MN has features as follows:

- Connection Mode: Register & Connect Mode
- It has to connect to the ENm using an outgoing connection.
- It has 6 Incoming Connection, and can have up to 6 connections with SN and/or EN.
- Acts as the master router in HandyPort Network.
- Uses the extended command mode

4.2.1. MN Settings

This is the procedures of configuring MN in MN-SN-EN Network.

Step 1: Push the RST button to enter the setup mode, and hit a <CR> after 5 sec.

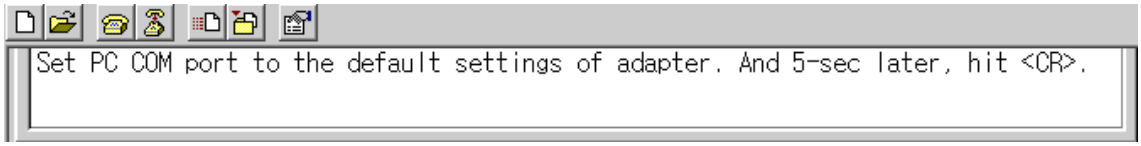


Figure 4-5 Enter the Setup Mode at MN

Step 2: Type a command, LM, and type “2<CR>” to change the multipoint mode to MN.

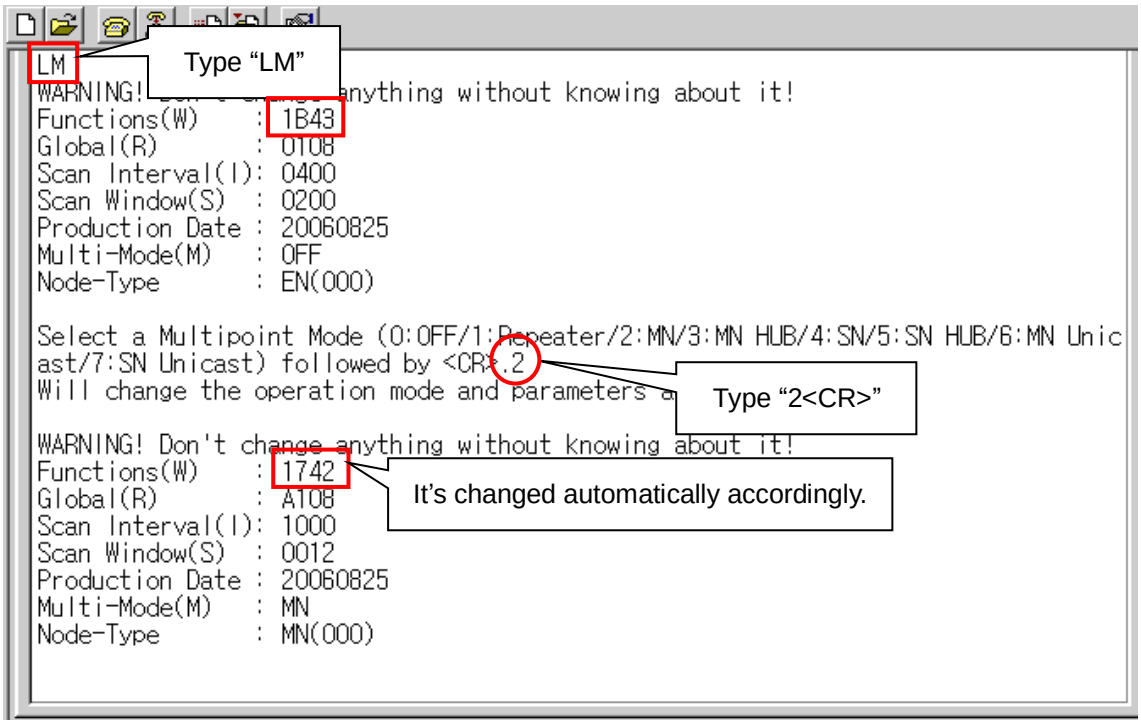


Figure 4-6 Configure the Multipoint Mode at MN

Step 3: Type a command, A, and type the BD_ADDR of ENm followed by <CR> to configure the remote BD_ADDR for MN. And find out the BD_ADDR of MN for SN and EN.

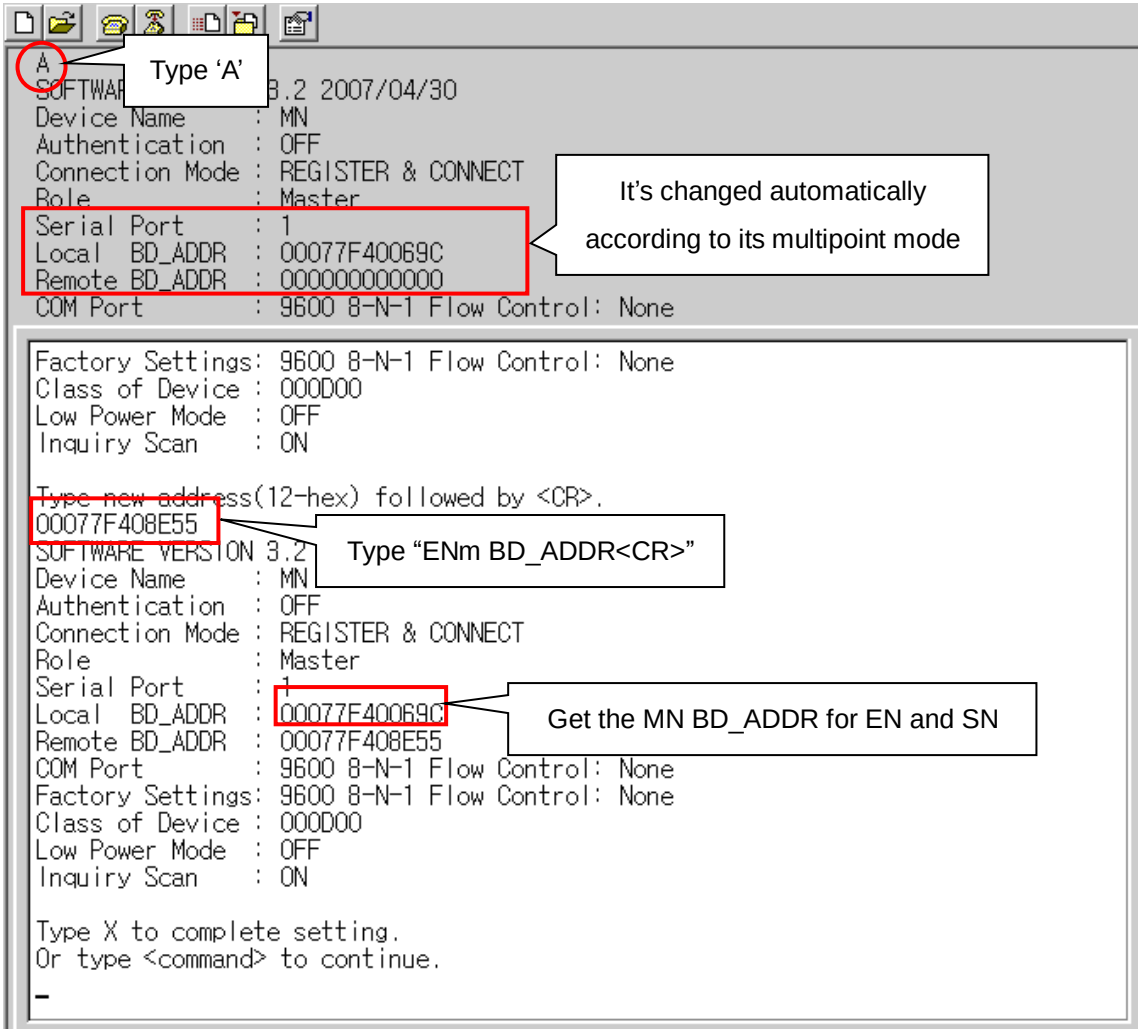


Figure 4-7 Configure the Remote BD_ADDR at MN

Step 4: Verify the changes and type a command, X, to apply the changes and reboot.

Figure 4-8 Execute 'X' at MN

4.2.2. MN Settings-Adr

This is the procedures of configuring MN with address mode in MN-SN-EN Network.

Step 1: Push the RST button to enter the setup mode, and hit a <CR> after 5 sec.

Step 2: Type a command, LM, and type “2<CR>” to change the multipoint mode to MN. (Please refer to Figure 4-6)

Step 3: Type a command, LA, and type “1<CR>” to activate the address mode of MN.

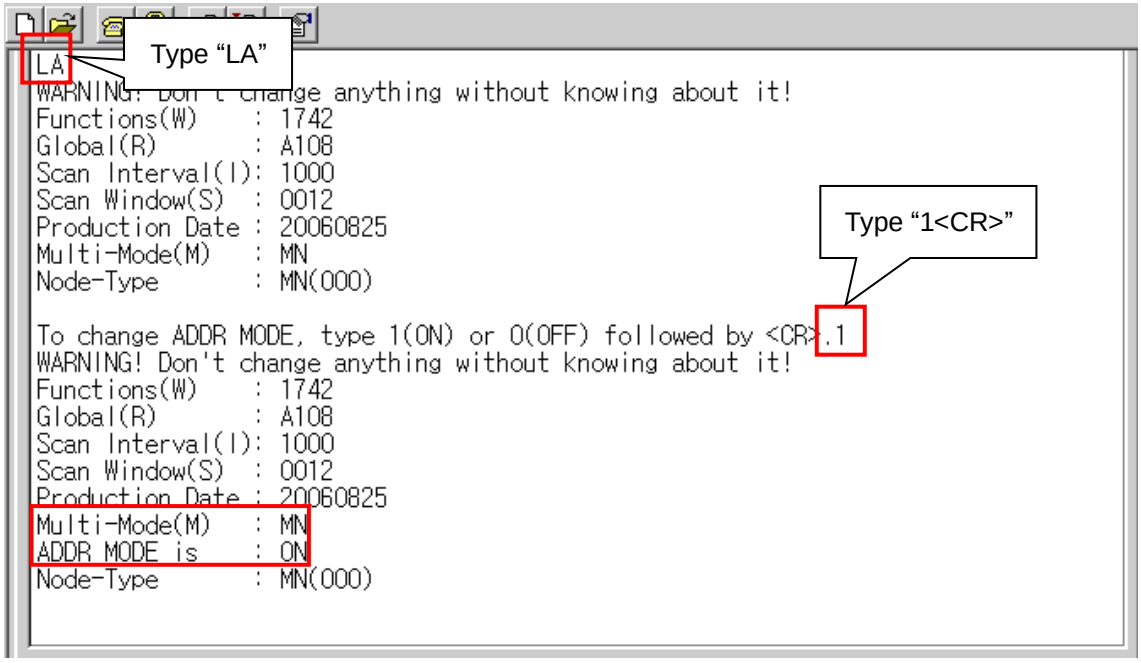


Figure 4-9 Configure the Remote BD_ADDR at MN

Step 4: Type a command, A, and type the BD_ADDR of ENm followed by <CR> to configure the remote BD_ADDR for MN. And find out the BD_ADDR of MN for SN and EN. (Please refer to Figure 4-7)

Step 5: Verify the changes and type a command, X, to apply the changes and reboot.

4.2.3. MN Settings-HUB

This is the procedures of configuring MN HUB in MN HUB-SN HUB-EN Network.

The procedures are the same as section 4.2.1 except typing “3<CR>” at step 2.

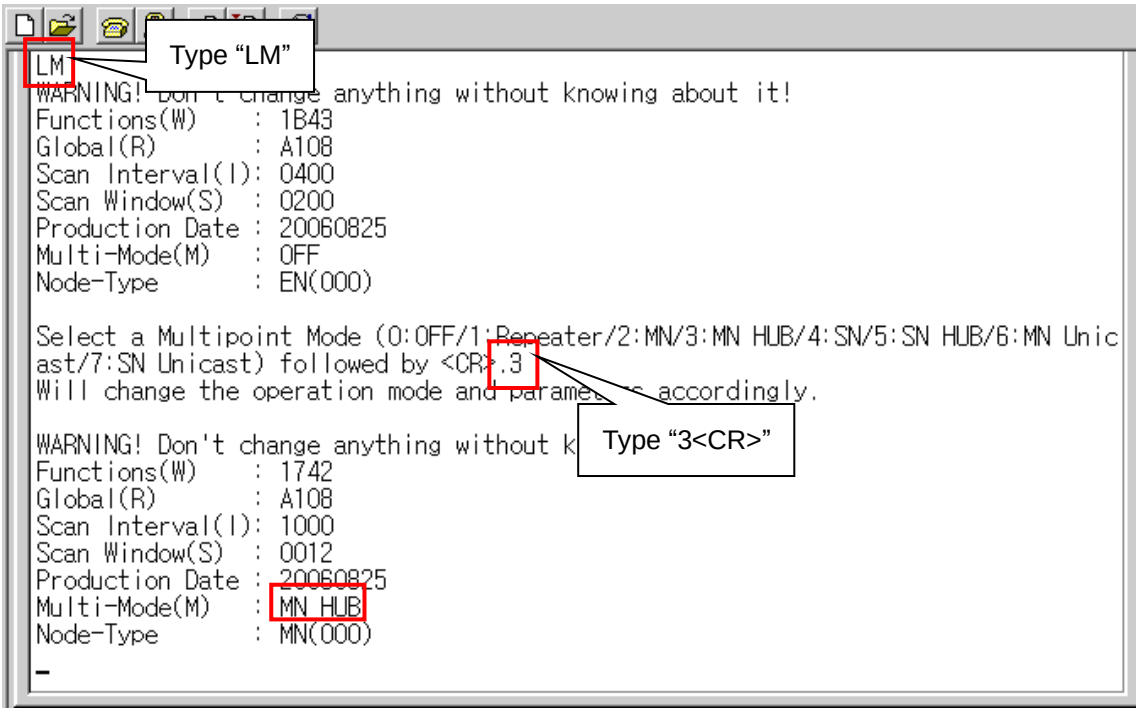


Figure 4-10 Configure the MN HUB

4.2.4. MN Settings-Uni

This is the procedures of configuring MN Unicast in MN Unicast-SN Unicast-EN Network.

The procedures are the same as section 4.2.1 except typing “6<CR>” at step 2.

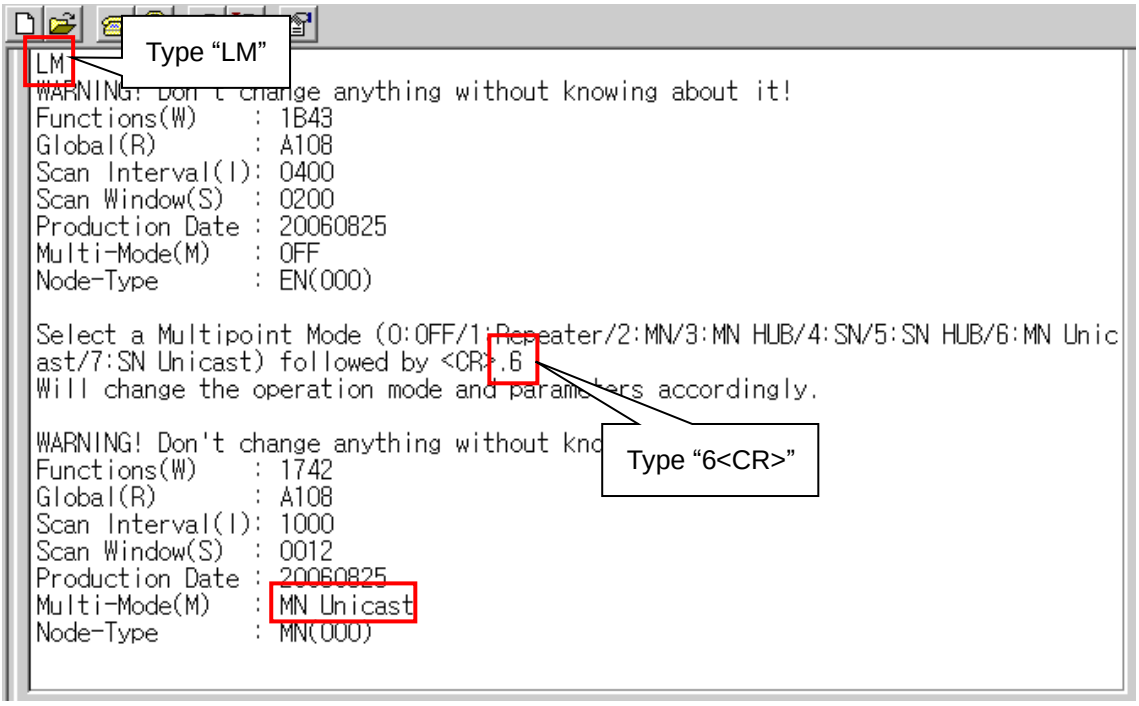


Figure 4-11 Configure the MN Unicast

4.3. SN Configuration

This section describes the procedures of configuring SN. The SN has features as follows:

- Connection Mode: Register & Connect Mode
- It connects to the upper node using an outgoing connection.
- It has 6 Incoming Connections and can have up to 6 connections with SN and/or EN.
- Uses the extended command mode

4.3.1. SN Settings-A

This is the procedures of configuring SN with the search mode in MN-SN-EN network.

Step 1: Push the RST button to enter the setup mode, and hit a <CR> after 5 sec.

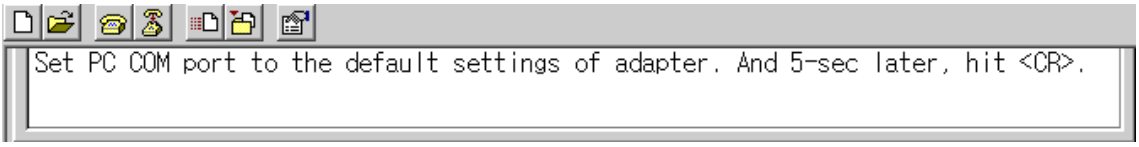


Figure 4-12 Enter the Setup Mode at SN

Step 2: Type a command, LM, and type “4<CR>” to configure its multipoint mode to SN.

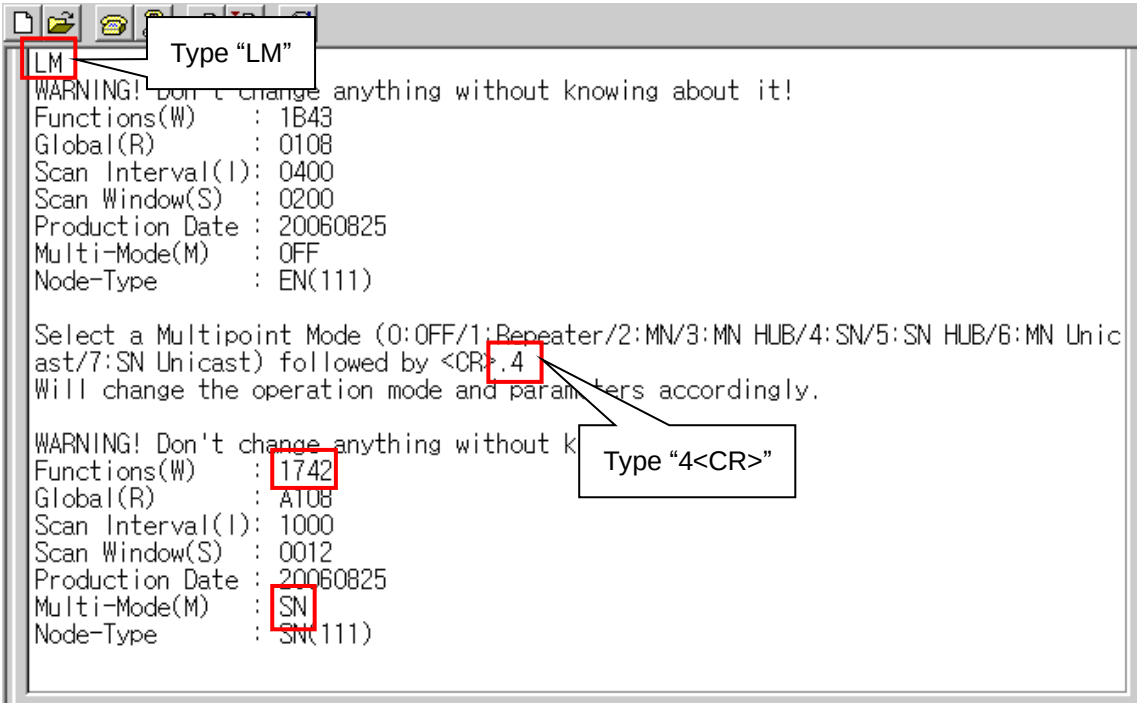


Figure 4-13 Configure the SN

Step 3: Type a command, LF, and type “1<CR>” to activate the search mode.

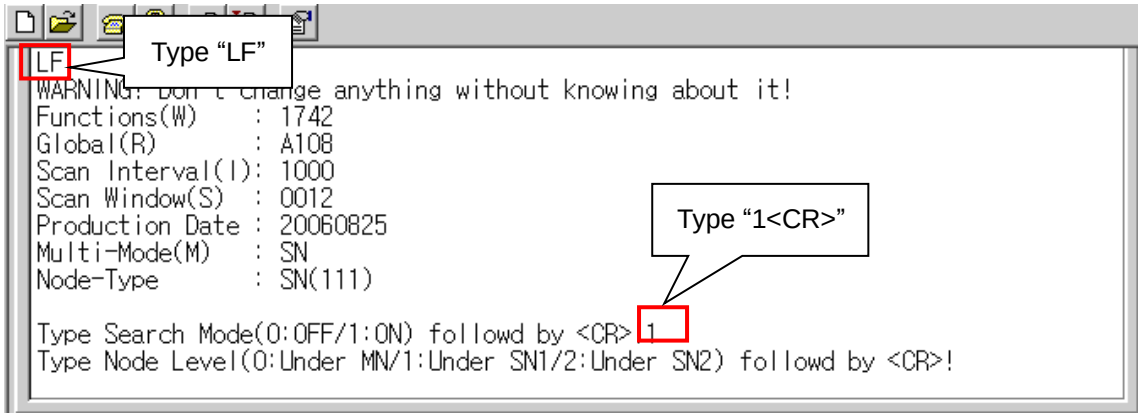


Figure 4-14 Configure the Search Mode at SN

Step 4: Type a Node Level followed by <CR>. The Figure 4-15 shows an example of node level 0. You have to configure it accordingly.

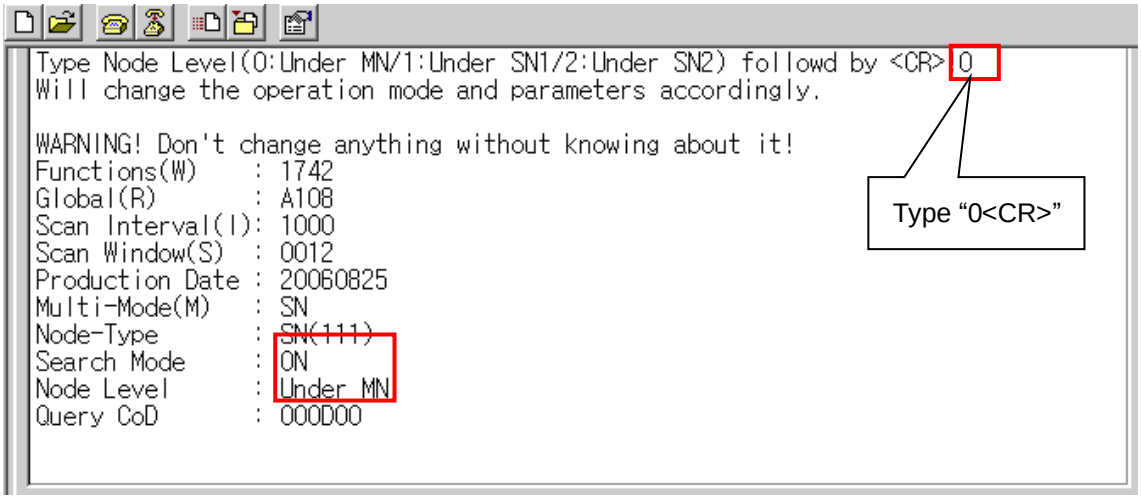


Figure 4-15 Configure the Node Level at SN

Step 5: Verify the changes and type a command, X, to apply the changes and reboot.

Figure 4-16 Execute X at SN

4.3.2. SN Settings-M

This is the procedures of configuring SN with the manual setting in MN-SN-EN network.

Step 1: Push the RST button to enter the setup mode, and hit a <CR> after 5 sec.

Step 2: Type a command, LM, and type "4<CR>" to configure its multipoint mode to SN. (Please refer to Figure 4-13)

Step 3: Type a command, A, and type the upper node's BD_ADDR followed by <CR> to configure the remote BD_ADDR for SN. Find out the BD_ADDR of SN for EN or SN.

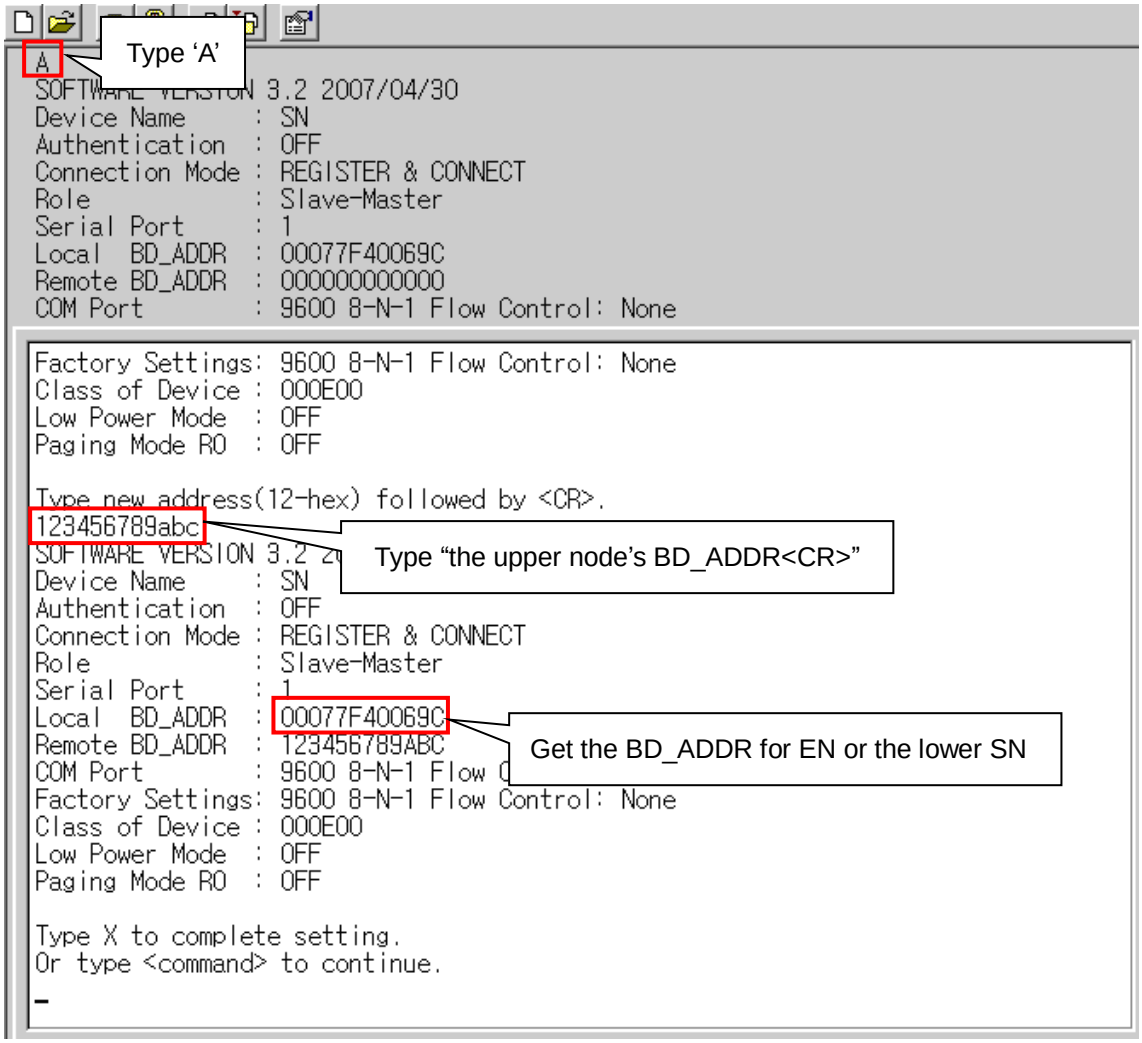


Figure 4-17 Configure the remote BD_ADDR at SN

Step 4: Type a command, C, and type a number of Serial Port followed by <CR>. The Serial Port shall be from '1' to '6'. You shall not use '7'.

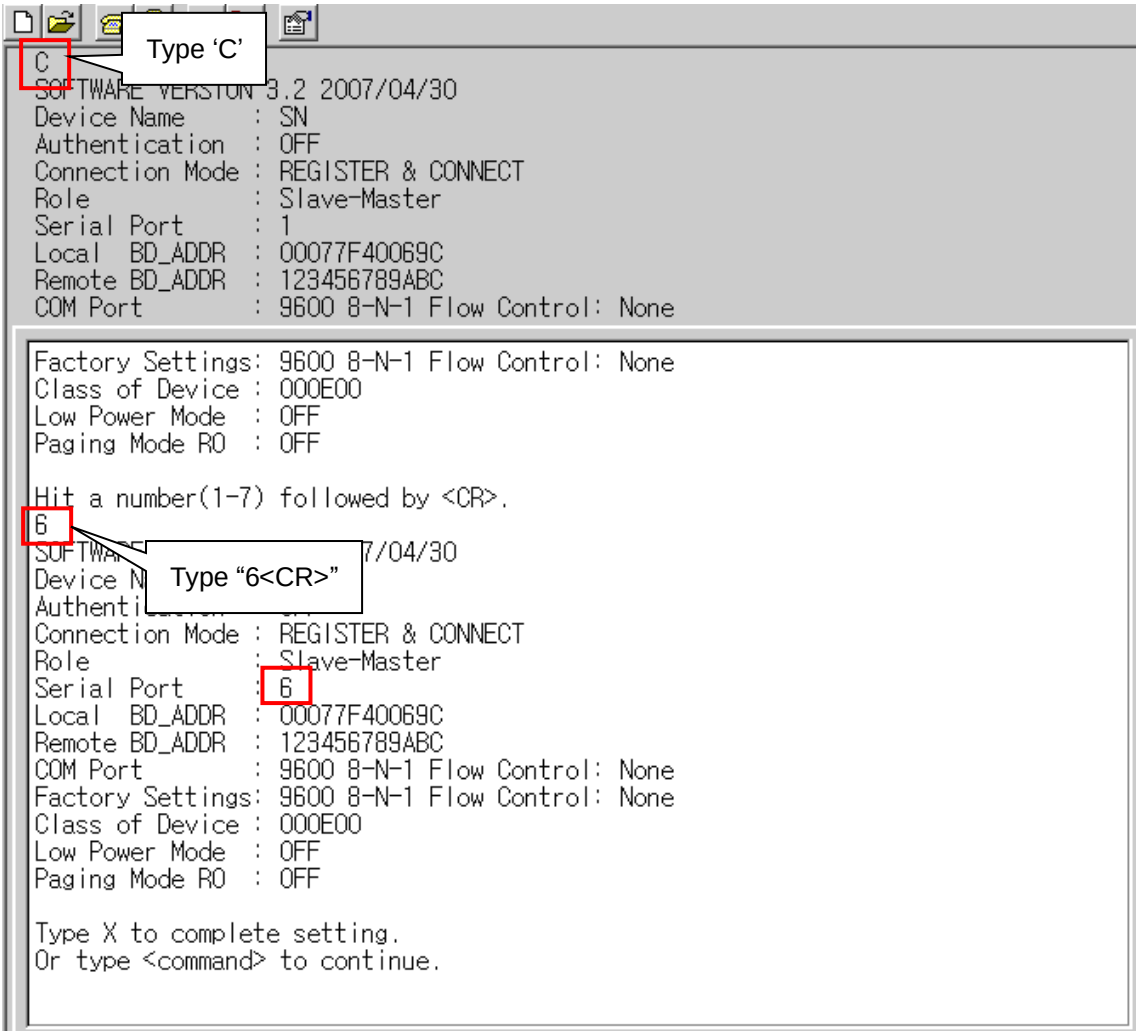


Figure 4-18 Configure the Serial Port at SN

Step 5: Verify the changes and type a command, X, to apply the changes and reboot.

4.3.3. SN Settings-AdrA

This is the procedures of configuring SN with the search mode and address mode in MN-SN-EN network.

Execute the step from 1 to 4 in section 4.3.1 and type a command, LA, and type “1<CR>” to activate the address mode for SN.

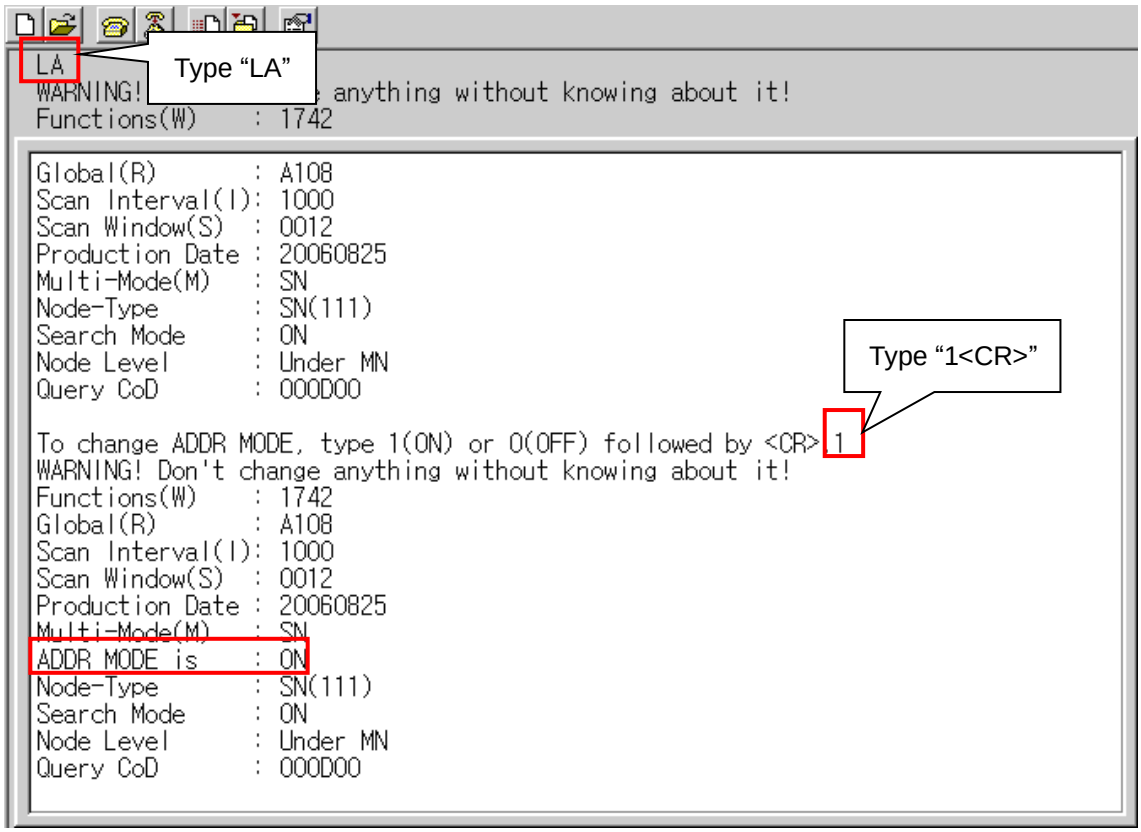


Figure 4-19 Configure the Address Mode in Search Mode at SN

Execute the step 5 in section 4.3.1.

4.3.4. SN Settings-AdrM

This is the procedures of configuring SN with the manual setting and address mode in MN-SN-EN network.

Execute the step 1 to 4 in section 4.3.2. And type a command, LA, and type “1<CR>” to activate the address mode.

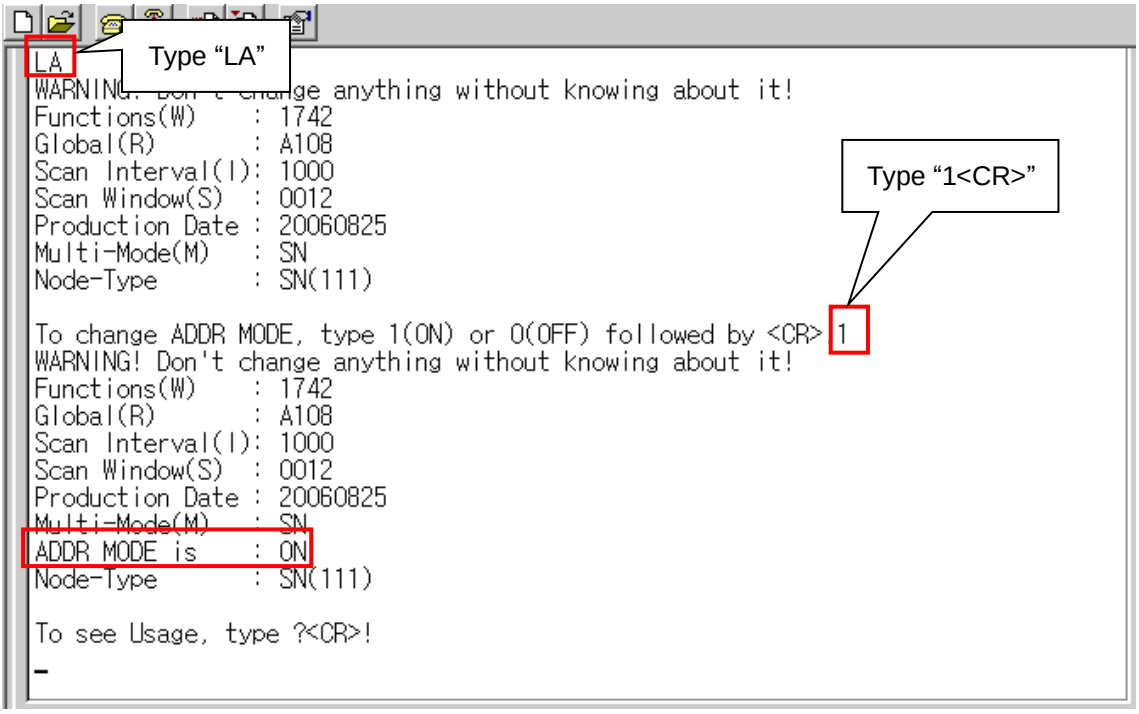


Figure 4-20 Configure the Address Mode in Manual Setting at SN

Execute the step 5 in section 4.3.2.

4.3.5. SN Settings-HUBA

This is the procedures of configuring SN HUB with the search mode in MN HUB-SN HUB-EN network.

The procedures are the same as section 4.3.1 except typing “5<CR>” in step 2.

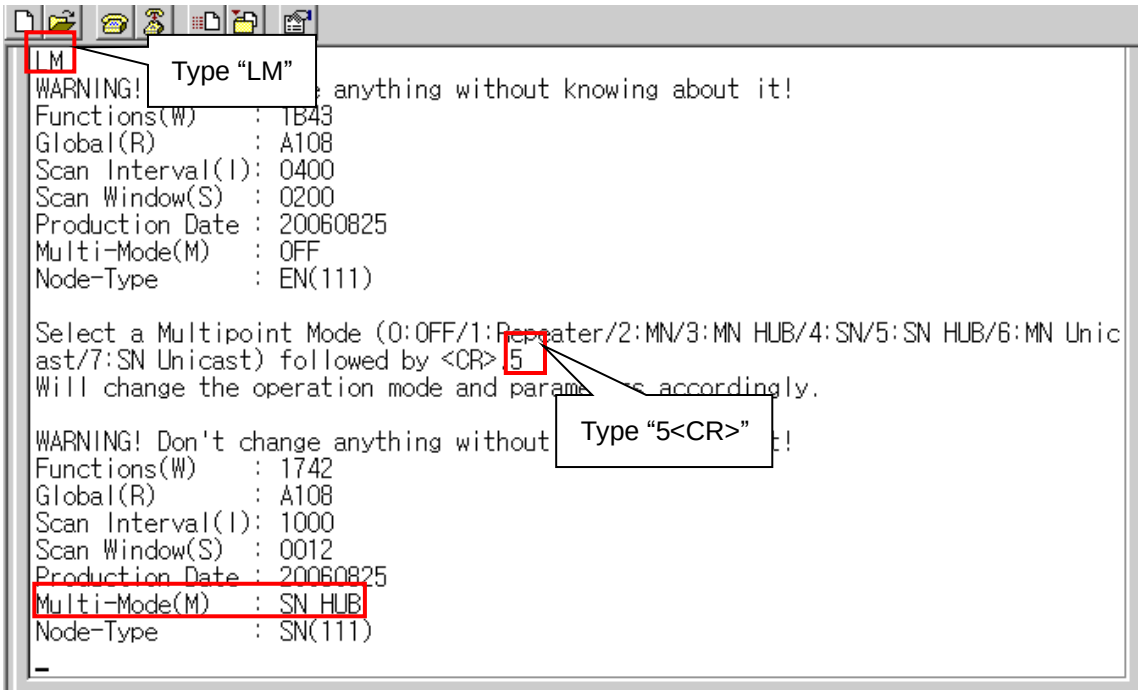


Figure 4-21 Configure the SN HUB

4.3.6. SN Settings-HUBM

This is the procedures of configuring SN HUB with the manual setting in MN HUB-SN HUB-EN network.

The procedures are the same as section 4.3.2 except typing “5<CR>” in step 2. Please refer to Figure 4-21 to see how to configure the SN HUB.

4.3.7. SN Settings-UniA

This is the procedures of configuring SN with the search mode in MN Unicast-SN Unicast-EN network.

The procedures are the same as section 4.3.1 except typing “7<CR>” in step 2.

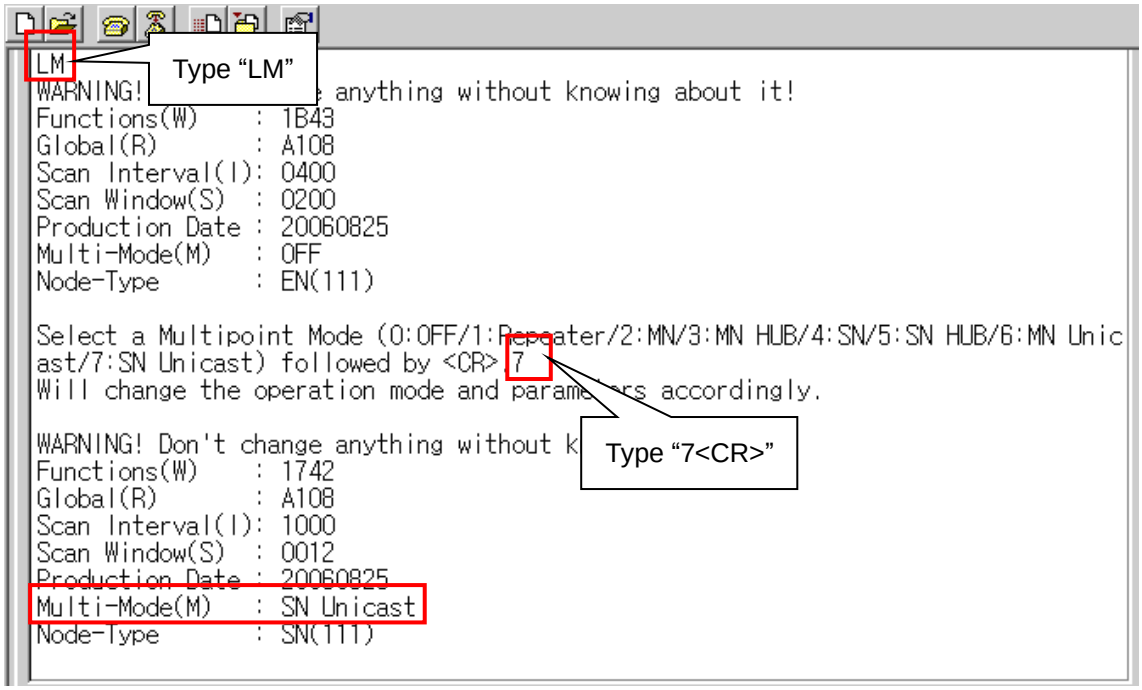


Figure 4-22 Configure the SN Unicast

4.3.8. SN Settings-UniM

This is the procedures of configuring SN with the manual setting in MN Unicast-SN Unicast-EN network.

The procedures are the same as section 4.3.2 except typing “7<CR>” in step 2. Please refer to Figure 4-22 to see how to configure the SN Unicast.

4.4. EN Configuration

The EN can connect to a device that has a serial interface. The EN has features as follows:

- Connection Mode: Register & Connect Mode
- It has an Outgoing Connection and it can connect to the MN or SN.

4.4.1. Configure EN Settings-A, EN Settings-HUBA, and EN Settings-UniA

This is the procedures of configuring EN with the search mode.

Step 1: Push the RST button to enter the setup mode, and hit a <CR> after 5 sec.

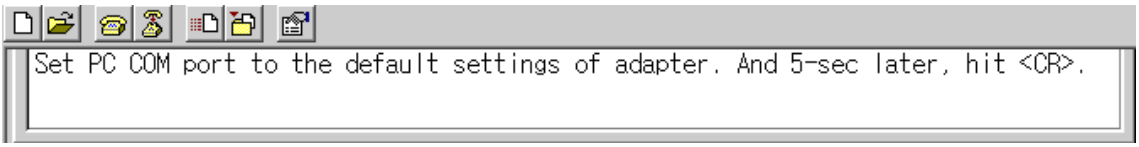


Figure 4-23 Enter the Setup Mode at EN

Step 2: Type a command, LF, and type “1<CR>” to activate the search mode.

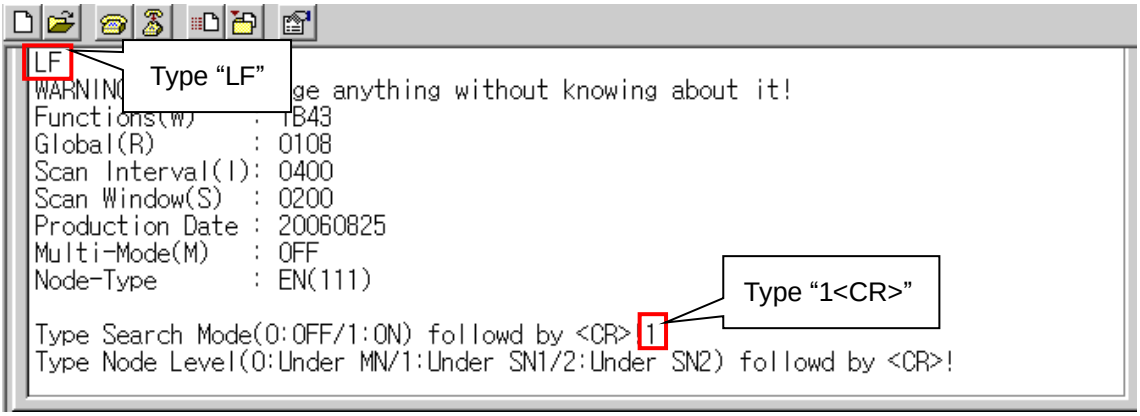


Figure 4-24 Configure the Search Mode at EN

Step 3: Type the Node Level followed by <CR>. The Figure 4-25 shows an example of node level 0. You have to configure it accordingly.

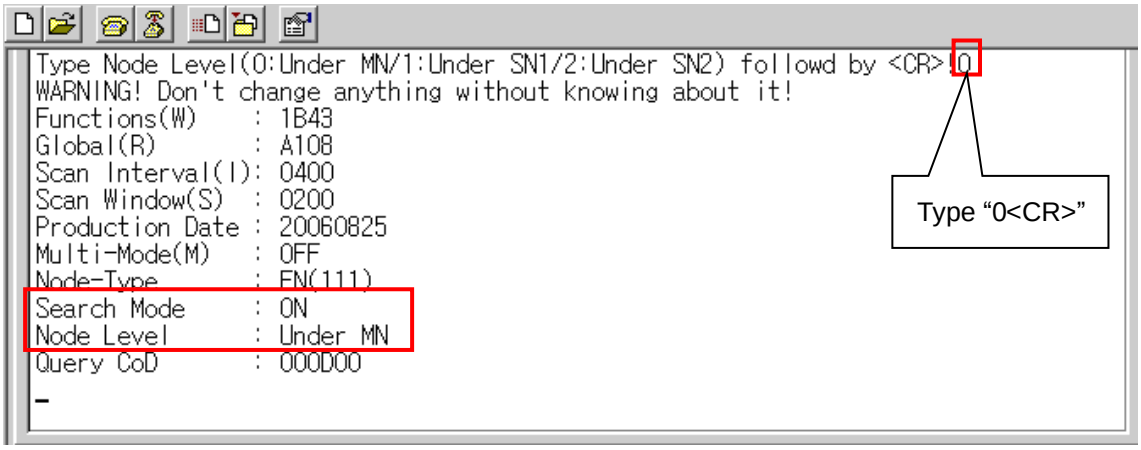


Figure 4-25 Configure the Upper Node at EN

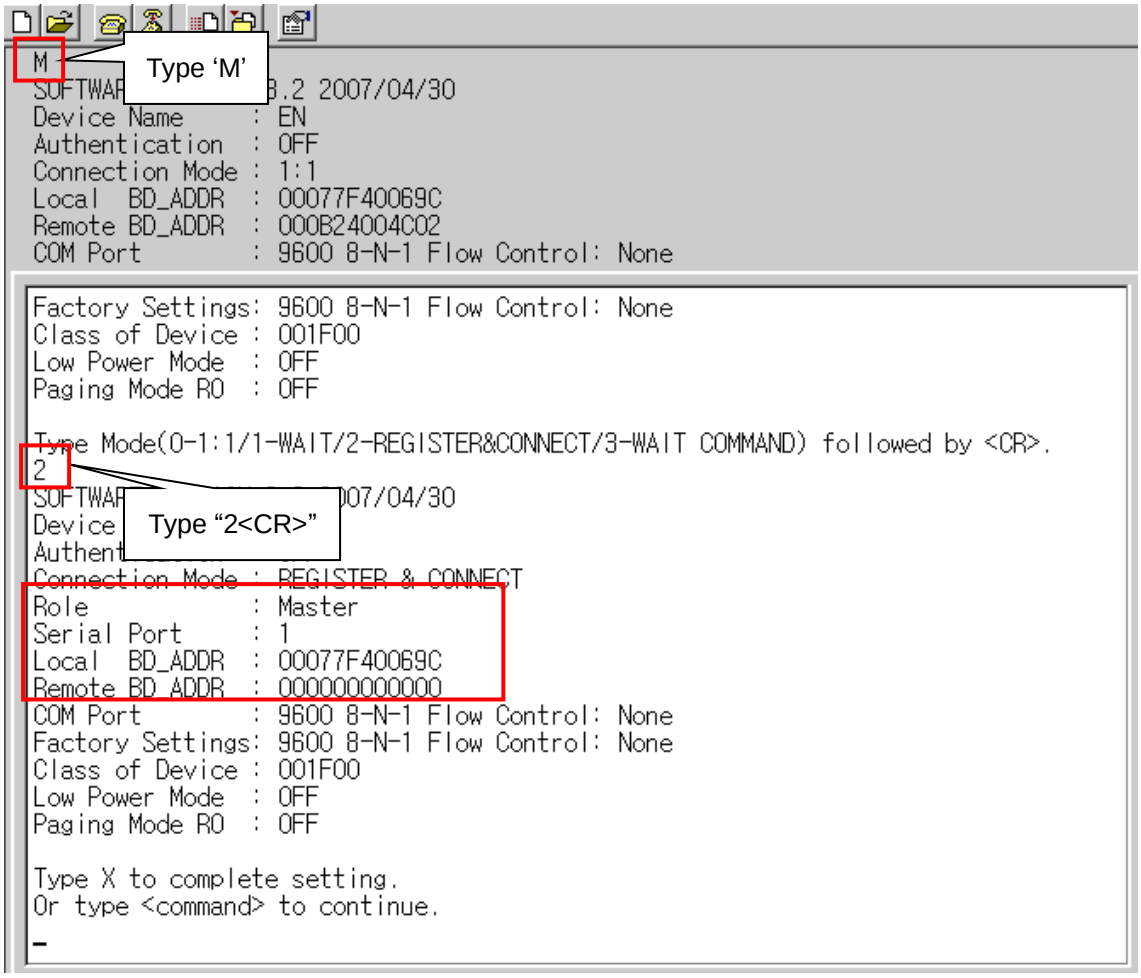
Step 4: Verify the changes and type a command, X, to apply the changes and reboot.

4.4.2. Configure EN Settings-M, EN Settings-HUBM, and EN Settings-UniM

This is the procedures of configuring EN with the manual setting.

Step 1: Push the RST button to enter the setup mode, and hit a <CR> after 5 sec.

Step 2: Type a command, M, and type “2<CR>” to change its connection mode to Register & Connect mode.




```
M
SOFTWAR   .2 2007/04/30
Device Name     : EN
Authentication  : OFF
Connection Mode : 1:1
Local  BD_ADDR  : 00077F40069C
Remote BD_ADDR  : 000B24004C02
COM Port        : 9600 8-N-1 Flow Control: None

Factory Settings: 9600 8-N-1 Flow Control: None
Class of Device : 001F00
Low Power Mode  : OFF
Paging Mode RO  : OFF

Type Mode(0-1:1/1-WAIT/2-REGISTER&CONNECT/3-WAIT COMMAND) followed by <CR>.
2
SOFTWAR        007/04/30
Device
Authent
Connection Mode : REGISTER & CONNECT
Role            : Master
Serial Port     : 1
Local  BD_ADDR  : 00077F40069C
Remote BD_ADDR  : 000000000000
COM Port        : 9600 8-N-1 Flow Control: None
Factory Settings: 9600 8-N-1 Flow Control: None
Class of Device : 001F00
Low Power Mode  : OFF
Paging Mode RO  : OFF

Type X to complete setting.
Or type <command> to continue.
-
```

Figure 4-26 Configure the Connection Mode at EN

Step 3: Type a command, A, and type the upper node's BD_ADDR followed by <CR> to configure its remote BD_ADDR.

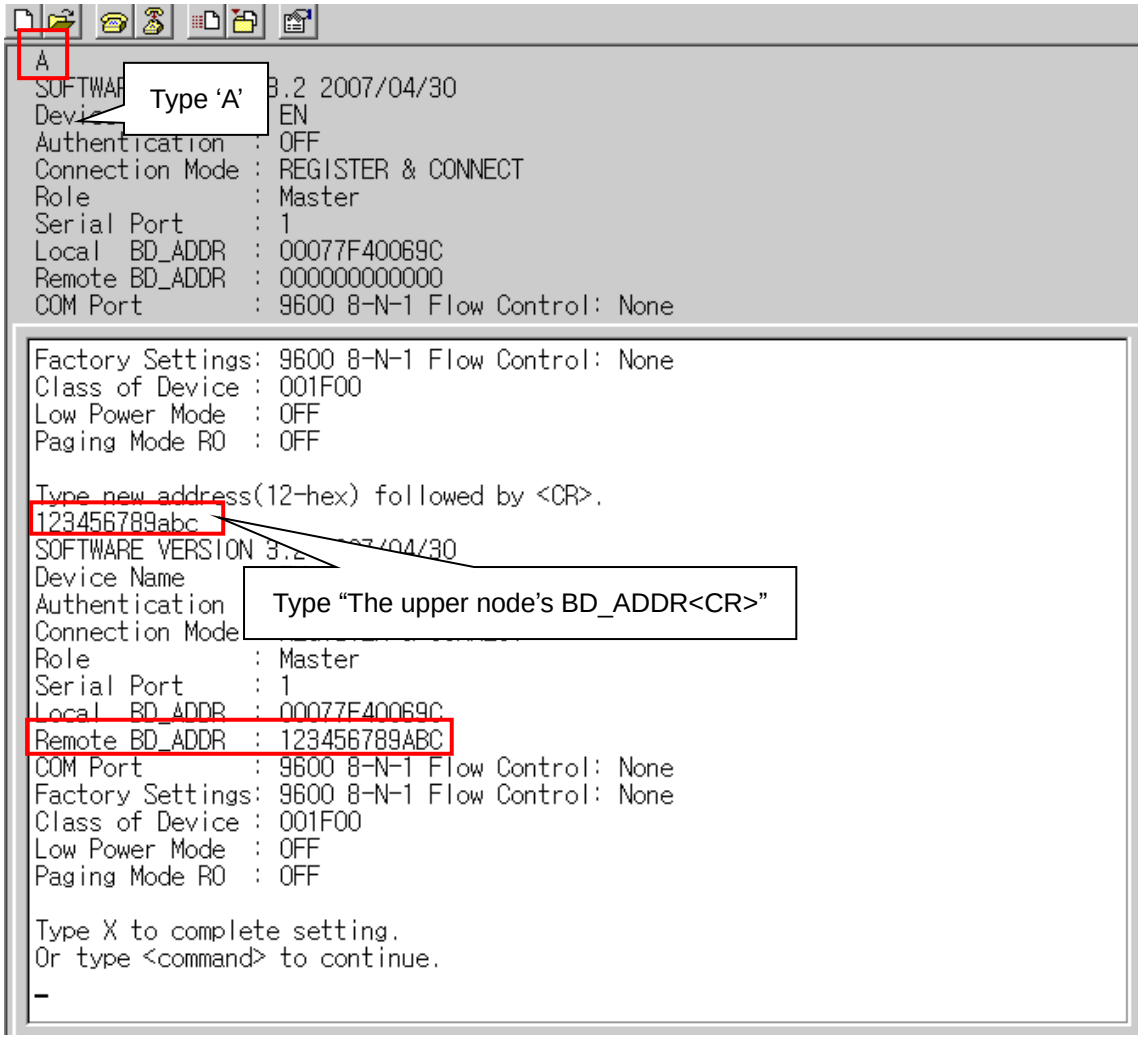


Figure 4-27 Configure the Remote BD_ADDR at EN

Step 4: Type a command, C, and type a number of Serial Port followed by <CR>. The Serial Port shall be from '1' to '6'. You shall not use '7'.

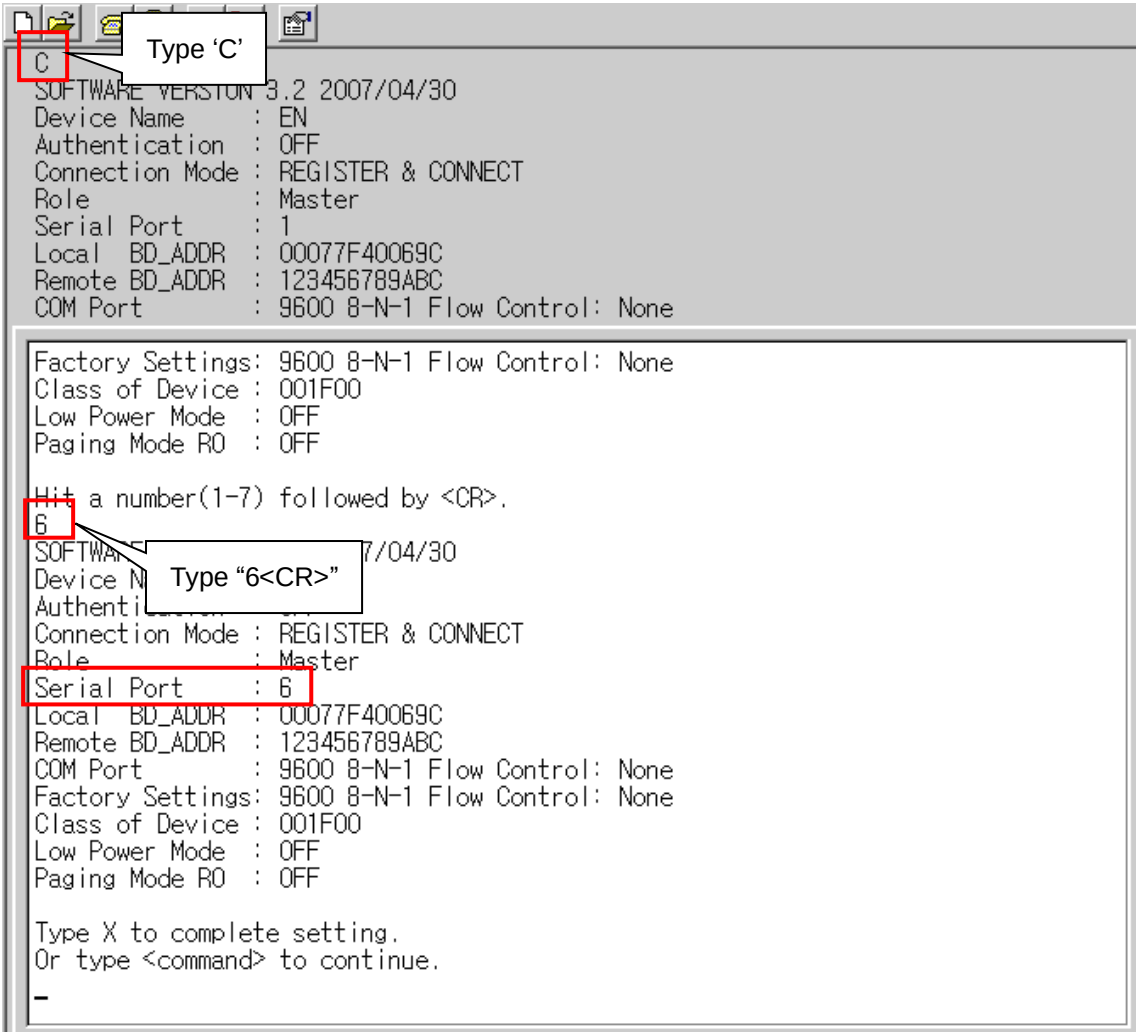


Figure 4-28 Configure the Serial Port at EN

Step 5: Verify the changes and type a command, X, to apply the changes and reboot.

4.4.3. EN Settings-AdrA

This is the procedures of configuring EN with the search mode and address mode in MN-SN-EN network.

Execute the step from 1 to 3 in section 4.4.1. And type a command, LA, and type “1<CR>” to activate the address mode.

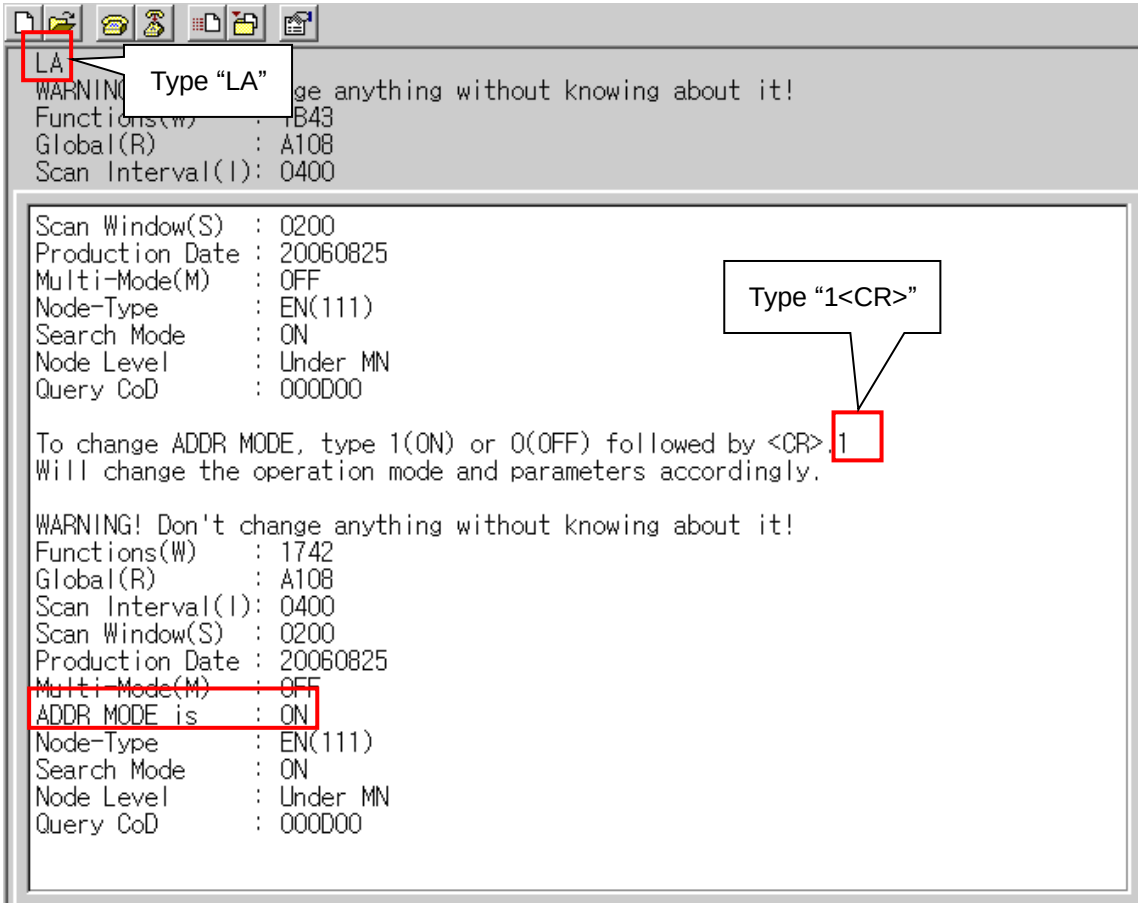


Figure 4-29 Configure the Address Mode at EN

Verify the changes and type a command, X, to apply the changes and reboot.

4.4.4. EN Settings-AdrM

This is the procedures of configuring EN with manual setting in MN-SN-EN network.

Execute the step from 1 to 4 in section 0. And type a command, LA, and type “1<CR>” to activate the address mode. (Please refer to Figure 4-29 to see how to activate the address mode.)

Verify the changes and type a command, X, to apply the changes and reboot.